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TROPICAL AGRICULTURE is published monthly at the Imperial College of Tropical Agriculture, St. Augustine, Trinidad, West Indies. Advertisement and subscription rates can be obtained at the College from the Editor, or from the Secretary of the College, 14, Trinity Square, London, E.C. 3, England. The Editor will be glad to consider authoritative articles for publication. It is understood that opinions expressed or recommendations made in signed articles or in articles of which the source is named are those of the author and do not necessarily represent the policy or opinion of the College Authorities. Increasing numbers of inquiries are being received from various parts of the tropics which can be answered only by persons possessed of an intimate knowledge of local conditions. Enquirers should first satisfy themselves that their local Department of Agriculture is not able to supply them with the desired information before communicating with us. Correspondence which will be replied to is invited on all other matters pertaining to tropical agriculture, science and development.

TROPICAL SOIL SURVEYS.

DURING September, it is proposed to hold at Rothamsted, a conference on soil science problems, under the auspices of the newly formed Imperial Bureau of Soil Science, of which the director is Sir John Russell, and deputy, Dr. A. F. Joseph. The preliminary discussions at the Imperial Agricultural Conference convened in 1927, when the Bureau was inaugurated, centred round four main subjects. The first was soil classification, a subject which has by no means been finally settled, but which is at present undergoing considerable changes in aspect since the newer ideas and methods of the Russian school of soil investigators have become available. A considered method of soil classification applicable to British soils is about to be issued by the Bureau. It is largely based on experiences established by the United States Bureau of Soils, one of whose senior officers (Dr. L. L. Lee) has recently prepared a valuable field memorandum for the guidance of British soil surveyors. Dr. Lee's article appeared as Technical Communication No. 6 of the Imperial Bureau's Publications. It clearly describes a survey method used nowadays in the United States of America, and suggests the bearing of soil profile studies on the classification of temperate soils. So far, however, no serious consideration appears to have been given by the Bureau to the questions of soil classification and mapping within the Tropical Empire.

The second subject discussed at the Imperial Agricultural Conference in 1927, was the time-honoured topic of soil mechanical analysis. It was decided to adopt the methods selected by the International Society of Soil Science, at least until some more suitable scheme, based on the wider experience of British soil investigators, both at home and overseas, could be utilized. The third subject, fertilizer trials, has nowadays become so specialized, that it has been practically elevated to a separate science, dominated by the statistician. The fourth subject, soil deterioration, has evoked considerable exchange of ideas, and has led to the issue of another Technical Communication (No. 5) on the important topic, soil erosion.

Arising out of discussions on soil classification, the need of a soil survey of the British Empire has been stressed. So far, chief interest has centred round a soil survey of the Tropical West African Colonies, which was fully discussed at the Second West African Conference held at Accra towards the end of 1929. Some valuable notes by Dr. F. J. Martin and Mr. H. C. Doyne were

presented at this meeting; they describe the work that has been going on during the past three years in the soils laboratory of the Agricultural Department of Sierra Leone. Analyses of some typical soils collected in West African territory are presented; they include mechanical composition, chemical composition of the clay fraction, and plant nutrients soluble in conventional acidic solutions. The systematic laboratory work in connection with the West African soil survey has apparently only just been started. Difficulty in obtaining samples of soil, and lack of time at the disposal of the pioneering investigators have limited the progress of the work. Furthermore, for reasons of simplicity, soil sampling had to be confined to the first foot layer of soil instead of to advocated depths up to four feet.

It is unfortunate that facilities and personnel are lacking for the rapid prosecution of soil surveys, particularly in undeveloped tropical areas within the Empire. An accurate knowledge of the potentialities of the soil must always form the foundation of any schemes of agricultural development and land utilization; one would suggest that tropical agricultural departments would do well to create special sub-departments for soil exploration. Such soil departments might profitably work in close co-operation with departments of forestry.

The main aspects of soil survey work, with special reference to tropical countries, form the subject of three articles to appear in this Journal. The first of these deals with the broader aspects of reconnaissance surveying, which requires little laboratory aid, and might be completed before more detailed methods are brought into operation. The second aspect refers mainly to the significance of soil profile study, both in its application to broad reconnaissance and regional vegetation surveys, and in its bearing on the delineation and description of types of soil utilized by or suited to the growth of forest or orchard crops, such as cocoa, oil palms, citrus, rubber, banana, coffee and tea. It would appear obvious that the method best adapted to the survey of forest and orchard-crop soils, might not be the same as that applied to the survey of soils growing annual or biennial crops, such as sugar-cane, tobacco, cotton, cereals, fodder-grasses, ground provisions and pulses. In the one case, the land is usually brought in directly from its virgin state, and the crop is planted without soil disturbance, except perhaps through drain construction. In the other, the surface soil is constantly undergoing disturbance through implemental or hand tillage. Frequently seed-beds have to be prepared, and natural and artificial manures applied. All these tend to produce a made-up soil layer within which the plant-roots are mainly confined. Soil sampling to the full depth of this surface soil usually then furnishes material representative of the nutrient medium of the plant, and its examination in the laboratory aids in the interpretation and extension of detailed field experiments, as well as in the delineation of cultivated soils suited to particular crops or rotations of crops. Forest or orchard-crop land, however, should not be sampled in the same way. The best procedure here undoubtedly is the profile method, whereby the natural stratification of the soil is described and utilized in the selection of detailed soil samples, whose number for each profile may thus mount up to five or ten or even more, depending largely on the depth of root-penetration and the distance of the parent rock below ground level. An unfortunate and apparently unavoidable feature in the procedure for sampling orchard-crop soils, is therefore the fact that large numbers of soil samples must be procured before an attempt can be made to classify the soils of an area or plot them on a map. Unless the laboratory examination can be expedited by the employment of rapid approximate methods of soil analysis, requiring little knowledge and skill beyond that commanded by native laboratory assistants, there would appear to be little hope of the soil-profile method being applied on a large scale in tropical surveys. It is encouraging to note, however, that in recent years, methods for the rapid determination of factors such as mechanical texture, soil acidity, organic matter content, readily available and potential plant nutrients, have been elaborated. Experience indeed has demonstrated that these methods are highly satisfactory for the purposes mentioned; their employment in tropical soil surveys deserves widespread attention.

To the mind of the professional temperate-lands farmer, soil surveys of the type that were largely in vogue up to the early years of the present century have not proved as valuable as was at one time hoped. Many farmers have even maintained that they could classify soils better than the specialist soil-surveyor merely by observing plant-growth and soil behaviour in the field, and by "walking the land." An interesting controversy on this matter was sustained in the pages of our contemporary, *Facts About Sugar*, in the issues for 13th October, 8th December, 1928, 19th January, and 16th February, 1929. The discussion arose through the publication in the 8th September issue of a review by Dr. O. W. Willcox of the soil-survey work of Dr. O. Arrhenius in Java, which he adversely contrasted with a simultaneous survey by Dr. H. H. Bennett and Dr. R. V. Allison of the sugar lands of Cuba. Arrhenius' approach to the task he set himself in Java was first to explore the relationship between soil acidity and sugar yields. This involved the collection and testing of several thousands of soil samples, practically one sample from every field whose yielding capacity was known. The results indicate that the highest yields of sugar are obtained from soil that is slightly alkaline in reaction, a conclusion which Dr. Willcox points out is of considerable practical importance to the planter, and likely to be of more service than the delineation of soil-types based mainly on physical characteristics (texture, colour) such as were employed by Bennett and Allison in their soil survey of Cuba. In Dr. Willcox's words, "The message which Arrhenius has conveyed to the Java cane planters

is that conventional soil maps, and the elaborate mechanical and petrological analysis on which they are based, are futilities ; and that the only features worth taking the trouble to locate on a map of tillable soil are the actual factors which determine crop yields." In connection with Arrhenius' soil acidity maps, it is worthy of note that later he established a close relationship between soil reaction and the phosphate content of the soil, the more acidic soils containing the least phosphate. He constructed soil phosphate maps as well as acidity maps, and later still, soil nitrate maps, which, however, show no similarity to the others. The results of mechanical soil analyses were finally shown to have no definite relationship to such properties as permeability, workability, cracking and moisture retention, so that, in Dr. Willcox's words they are "not worth the trouble required to execute them," and "convey no definite message to practical farmers." To quote further, "a soil survey based on mechanical soil types answers neither of the questions, 'How shall the poor ground be distinguished from the bad?' and, 'How may the needs of the poor ground be recognised?'" Professor F. S. Earle of Cuba adds a rejoinder to Dr. Willcox's criticisms, in the 13th October, 1928 issue of *Facts About Sugar*, in which, without opposing his opinions, he indicates some important divergencies from Arrhenius' generalizations, and puts forward a plea in favour of "mechanical" soil types. Dr. V. J. Koningsberger, of Java, in the issue for 8th December, attempts next to reconcile the opposing views on the grounds that "soil science must deal with the soil complex as a whole ; its final aim is to analyse this complex and show how it has been produced from the interaction of geological, atmospherical, hydrological, and other factors." In different words, he stresses the ultimate value of fundamental soil studies. Without summarizing Dr. Earle's further contribution to the discussion, in which he points out that the one method of surveying is merely the complement of the other, nor Dr. A. G. McCall's clear exposition of the point of view of the United States Bureau of Soils (of which he is Chief), we may remark that the main differences of opinion between the protagonists are merely due to the fact that they are defending one or other of two different aspects of soil survey work. As Dr. McCall states, Arrhenius' work in Java would have been impossible if detailed plot and field yield-data had not been available, and indeed, Arrhenius himself was the first to admit this.

The controversy thus brings to light the fact that the sort of soil survey of direct value to farmers or planters who are growing crops on land that has long been under cultivation, is the one that is sometimes called the "physiological-ecological" soil survey, in which an attempt is made periodically to measure and to plot on maps as many of the fluctuating factors controlling crop-growth as can reasonably be investigated in field and laboratory. The success of this procedure obviously depends upon the previous accumulation of detailed knowledge and experience of the yielding capacity or productivity of the land, and this is available only in long-established agricultural countries. As regards the actual technique of the procedure, and the relative significance of the growth-factors which it is meant to assess, it is not intended here to deal, for the articles that are to appear in this Journal on the subjects of soil surveying and soil analysis adequately supply this information. The main object of this editorial is to stress the value of soil surveys to the agriculturist, and to indicate that there are several aspects of the subject and several kinds of surveys, each with its own objective, its own limitations and its own specialized technique. Failure clearly to recognize these facts may lead to further misunderstandings when the broad subject of soil surveys is under discussion.

CULTURAL AREAS IN AFRICA.

In *Africa* for January, Dr. Melville J. Herskovits applies to the ethnological problems of Africa the American method of 'cultural areas'! He suggests nine cultural areas: (1) Hottentot: essentially a herding culture but differing from the Bantu, in that there is no agriculture, and the women have much to do with the herds. The cattle are given as gifts in marriage, but for the wedding feast, not as a dowager. The language, with that of the Bushmen, is differentiated by the 'click.' (2) The Bushmen: with poor material culture, but high artistic and literary (folklore) ability. The dog is the only domesticated animal, and hunting is brought to a high degree of skill. (3) The East African cattle area: cattle determine a man's position and prestige, and are utilised in all the important ceremonials of life ; but they do not furnish food, excepting milk, or when eaten as a ceremonial offering or after they have died. Food is obtained from the produce of the fields, and is the work of the women, to whom the care of the cattle is forbidden. Polygamy prevails, being based on the number of cattle a man commands. (4) The Congo: predominantly agricultural. The people live in rectangular houses, make bark, cloth, use masks, practice cicatrisation, and carve human representations. The secret society is important. (5) The East Horn: not sharply differentiated, but shades off from East Africa. The camel and horse slowly take the place of cattle—a marginal area. (6) The eastern Sudan: a nomadic culture organised around live stock. Living in a hard desert area, their first care is the feeding and watering of their animals. The religion is Mohammedanism, and the social order is strongly paternal. Clothing is of cloth and the people live in tents. (7) The western Sudan: a marginal area, in which great kingdoms—Penin Bornu, Haussa—have arisen. The economic life is basically herding, agriculture, and trade. (8) Desert: a nomadic area dependent upon trade, camel and horse breeding. (9) Egypt: an area distinct from the rest of Africa, of which the influence on other African culture must have been profound.—(*Nature*, Vol. 125, No. 3150.)

IRRIGATION IN THE ARGENTINE.

H. McLUSKIE,
Superintendent of Agriculture, British Guiana.

Situation.

THE area known as the Irrigated Zone of the Rio Negro in the Argentine Republic lies in south latitude 39°, six to seven hundred kilometres from the Atlantic Ocean. It has its birth on the lower reaches of the Rio Neuquen, which rising in the Andes, flows south-east to join the Rio Limay, the two together forming the Rio Negro, which thence continues its course unchecked to the Atlantic.

The country surrounding the irrigated zone is a vast, more or less arid and alkali desert, which in the north beyond the Rio Colorado merges into the Great Pampas, in the south into that vast country known as Patagonia, and to the west gradually rises to the foothills of the Andes.

There is little vegetation. The landscape is dotted with stunted salt bush, which, more often than not, is clothed with sharp spines, and varies in height from place to place. Where alkaline conditions are very prevalent, the salt bush may disappear altogether, leaving a bare flat upon which a thick encrustation of white and dark crystals occurs. Sometimes the bush becomes high enough to hide a horseman. The monotony of the landscape is relieved by bare ridges, which, in the sunset, reflect more beautiful colour schemes than can be pictured by the most vivid imagination. The rivers in this region are few but large. They have no tributaries, but merely traverse the country on their way to the sea, leaving a vale of alluvial fertility and occasional Patagonian willows along their course.

From the meeting point of the rivers Neuquen and Limay, two main trails diverge. One goes north-west to the mining district of Chos Malal, and the other traverses south-west to the lake district of Nahuel Huapi. The southern trail is now used by tourists, but the northern trail is still untrammelled by modern transport, and is only used by prospectors and Indians who come from their homes in the Andes to trade wool and the handiwork of their women folk.

Climate.

The climate of the Rio Negro is extremely dry and healthy, with a well-defined winter period. The sun shines practically every day with a brilliance usually attributed to arid regions, and, even, in the winter, the days are bright and balmy. In the summer the temperature rises to 90° to 100° F. in the shade, and at night drops to 50° to 60° F., and on some occasions lower than that. Hot nights are experienced when the north wind blows, but such occasions are rare. The rainfall is negligible ; in the year 1924 it only amounted to 2.62 inches.

Soils.

The Irrigated Zone occupies the alluvial valleys of the Lower Neuquen and Upper Rio Negro rivers. It is an alluvial flat which has been cut out of the desert by the rivers. The sides of the valley are well defined and rise sharply to the desert above. The soils are mainly sandy, and the further one proceeds down the valley, the finer their texture becomes, although sometimes, they may approximate to clay. In the upper reaches of the valley, particularly near the river itself, stretches of sand dunes occur.

The following table indicates the nature of the soils :—

Reaction	**No. 1.** *Alkaline*	**No. 2.** *Alkaline*
	per cent.	*per cent.*
Moisture	2.8	2.9
Coarse sand	40.8	34.6
Fine sand	43.6	51.2
Calcareous matter ..	0.9	2.0
Organic matter	3.6	2.1
Clay	8.5	7.7
Humus	0.8	1.2

As has already been mentioned, the soils are alkaline in reaction. This alkalinity makes itself apparent in two main forms, viz. : white alkali and black alkali or " salitre ", as it is locally known. The former, unless it exists in very large quantities, is not harmful to crops, but black salitre will not, as a rule, allow of good cultivation.

Roughly, salitre consists of sodium compounds, such as chlorides, sulphates and carbonates. Generally speaking, the lighter soils are freer from salitre than the heavier soils.

The soils are extremely fertile, and when irrigated, are capable of producing heavy crops. They are deficient, however, in humus and nitrogen.

Below is given the conventional analysis of a Rio Negro soil taken from a field under lucerne.

	Per cent.
Total N.	0.12
Total Lime	4.45
Magnesia	1.10
P_2O_5	0.51
K_2O	0.40
Mineral Salts	5.37
Chlorides ..	Trace.
Sulphates ..	Trace.

Irrigation System.

The irrigation system arises at a place called Contra-Almirante Cordero on the river Neuquen, about 20 miles above its junction with the Limay. A dam stretches across the river to form a basin from which the irrigation water is drawn.

By the word dam, it might be assumed that the construction is such that a huge reservoir of water results. This is not so. The function of the dam is rather that of diverting from the course of the river to the main canal such quantities of water as are required for irrigation purposes. A more appropriate name would be " regulator ".

IRRIGATION IN THE ARGENTINE.

FIG. I.— *View on the Rio Negro, showing Patagonian Willows and the Escarpments.*

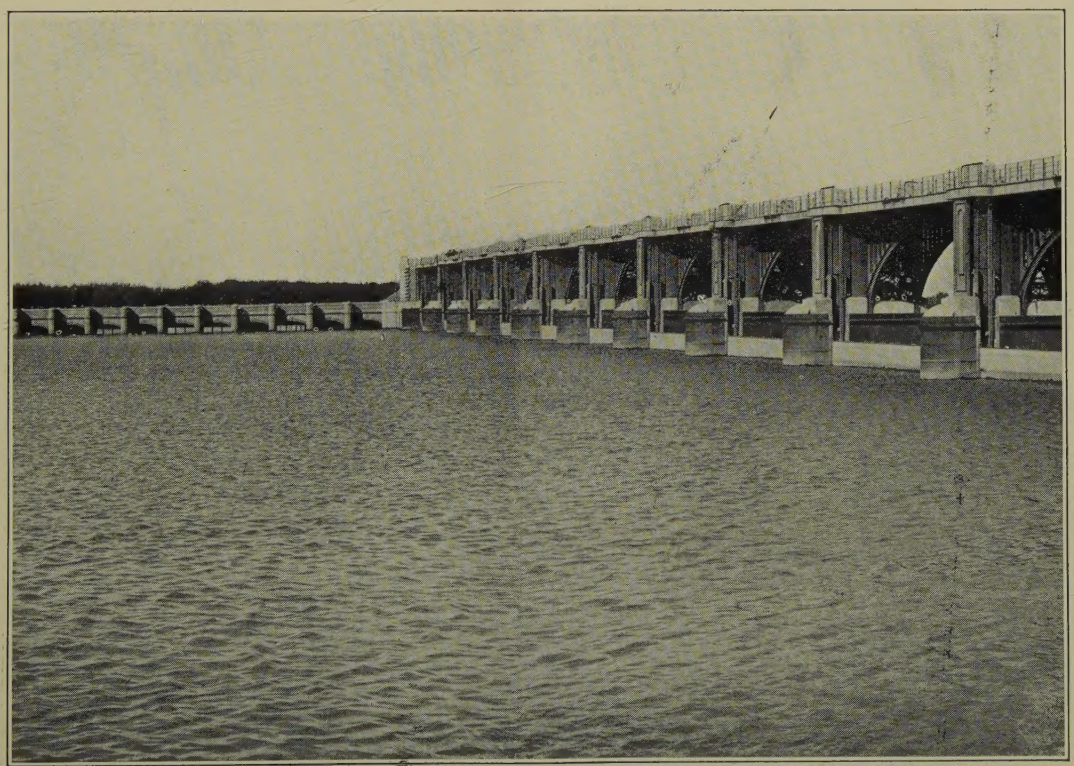

FIG. II.— *Irrigation of the Rio Negro Valley, F.C.S. Barrage and Intake of the Canal on the Rio Neuquen at C. Cordero.*

IRRIGATION IN THE ARGENTINE.

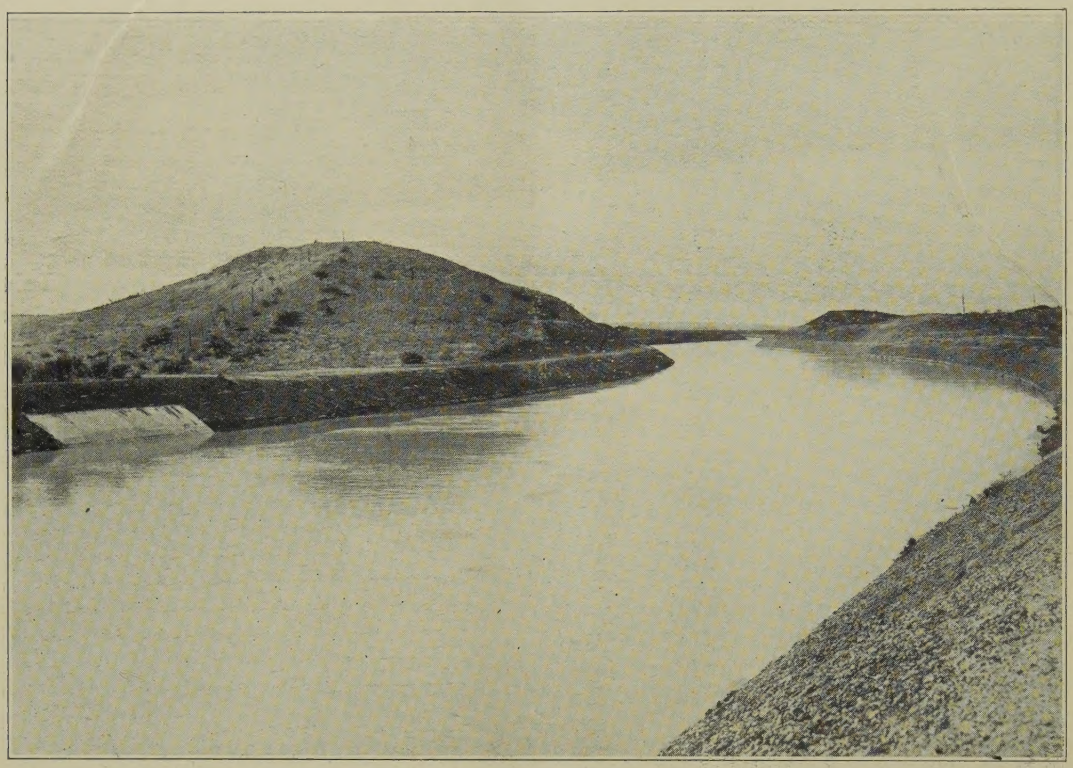

FIG. III.— *Irrigation of the Rio Negro Valley, F.C.S. "Big Cut" at Kilom.* 19, *looking down-stream.*

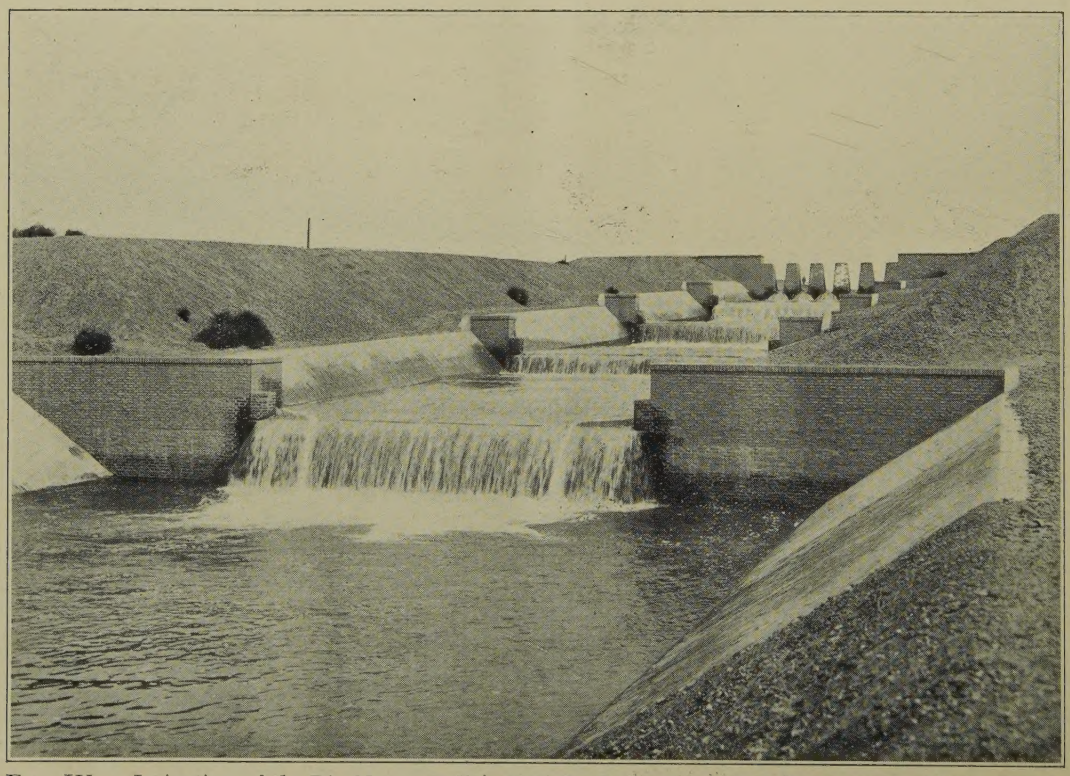

FIG. IV.— *Irrigation of the Rio Negro Valley, F.C.S. Falls at General Roca, on the Main Canal.*

The regulator consists of 17 sluice gates, each measuring 20 metres by 4 metres, which can independently be raised or lowered by an electric motor of 3 H.P. By means of these sluices, the quantity of water which flows into the main canal is controlled.

At the eastern end of the regulator is placed the main canal entrance, and through it flows the water which is destined to irrigate upwards of 30,000 hectares of land. This main canal has a total length of some 100 kilometres. Near its origin there is a deviation sluice or safety sluice through which the water can be diverted to a huge natural hollow known as the Quenca Vidal, in the event of any unforeseen contingency occurring in the main canal itself. As it progresses down the valley, this canal is provided at suitable intervals or localities with weirs. From the main canal a network of secondary and tertiary canals ramify throughout the valley. Each of these subsidiary intakes is in its turn controlled. Then from the tertiary canals, smaller canals and channels feed the farms through private sluices.

The sluice to each holding is padlocked by a Government inspector of irrigation, but as yet no shortage of water has occurred. For the water supply, each farmer pays the Government $10 per hectare. During the winter or dormant season, the water is entirely cut off and the canals are then cleared. At this time, by general arrangement with the growers, each farmer is also expected to clean his own internal irrigation ditches. Here it must be mentioned, that besides the irrigation canals, there is a series of drainage canals which remove surplus water from the land by emptying themselves into the river at various points down the valley.

Preparation of the Land.

The land in its virgin state is covered with bush, and the first procedure therefore on taking a farm is to clear it. Once the land is cleared a survey of levels must be made with the farm intake as starting point. Then levelling proceeds. In those parts of the valley where sand dunes occur, the process of levelling is more difficult and expensive. Under such circumstances

Diagram showing situation of Irrigation Zone.

terracing may be necessary. Generally, however, the greater part of the valley is fairly flat and only requires trimming. Levelling is usually carried out by contract at a certain price per hectare, the procedure being as follows :—

The land is first ploughed to loosen the surface and then rushed from the high spots to the hollows by large steel scoops, drawn by four to eight horses or mules. The levelling is done according to the position and course of the internal ditches. These ditches are usually built or dug whilst the levelling proceeds, and, as the ditch advances, so the water is allowed to flow along its course. As soon as an area of land is levelled, it is divided into suitable strips for watering by raising furrows or "*bordos*" at intervals.

A factor which exerts considerable adverse influence upon newly levelled land is the winds, which, in the Rio Negro area, can attain great violence. If certain precautions are not adopted to counteract their devastating effects, great damage may result. It is therefore essential when land is newly levelled to bind its surface by some means or other to prevent soil drifting, and wind-breaks must also be planted at the earliest opportunity.

In the construction of wind-breaks, two plants are chiefly used: the willow and the poplar. These can be propagated from cuttings, and are very rapid in growth. Willows are usually planted from stakes which are driven into the ground at intervals of three to four yards, and poplars from cuttings 12 to 18 inches long which are pushed into the sides of the irrigation ditches two to three feet apart. Poplars are frequently planted two, three or even four deep on strategic sides or on boundary lines, and when they have grown they form a very effective wall behind which, even in a gale, one can find adequate shelter. Wind-breaks of willows are also very effective. Owing to their spreading habit of growth, however, they do not require to be planted more than one deep, but they are frequently backed by a row or two of poplars.

As regards the binding of the surface of the land following levelling, the quickest method is to flood it. This is effective but not lasting. It is more usual therefore to bind the surface by means of a crop. The crop for such a purpose must necessarily be quick growing, and may be selected from the cereals or legumes. Rye is very suitable in that it completely covers the land and has a rapid growth. When it is about 12 to 18 inches in height it can be ploughed in, thus effectively increasing the humus content of the soil.

As in the case of the main irrigation system, so the internal systems of farms must be equipped with drainage channels to remove any excess of water. The general principles of irrigating fields are as follows :—

It has already been stated that the fields are sub-divided into "*bordos.*" In the case of orchards, a "*bordo*" may consist of one, two or three rows of trees. The water is run into the "*bordo*" from the ditch at the end of the field and allowed to flow until it completely covers the "*bordo*" and reaches its extreme end. The flow is then diverted to the next "*bordo.*" Meanwhile the extreme end of the flooded "*bordo*" is opened and the excess of water removed by a drainage channel.

When land which is fairly strong in alkali is thus washed, the overflow which passes off is often distinctly foamy with alkali. It is the practice therefore, instead of flooding land and allowing the water to soak in, rather to wash the land and remove with each washing, certain proportions of alkali. If a field were flooded, allowed to soak up, and then dried out, the incrustation of alkali on the surface would become quite apparent as a white layer. This is of course bad practice. Instead, the land should be washed, and when dried out sufficiently for cultivation, it should be mulched in order to check evaporation and subsequent deposition of alkali on the surface. Whole orchards of trees and vineyards have been ruined by the burning effect of alkali at the soil surface resulting from bad cultivation. The washing and after-cultivation of the land is therefore the correct method to adopt.

Cropping, &c.

It is not proposed in this article to describe the crops of the Rio Negro at length, but a few remarks on the products of the regions, however, may not be amiss.

The Rio Negro is especially adapted to temperate fruits such as apples, pears and grapes. It is true that peaches, nectarines, plums and small fruits all flourish, but, owing to the distance to the port and the abundant supply of these fruits at the port, they become uneconomic products. Lucerne, cereals, vegetables of all kinds flourish, and honey is produced on a large scale by a few enterprising colonists. Good red and white wines are also made locally. The entire valley is served by a first-class railway system, which can place goods upon the Bahia Blanco and Buenos Aires markets in 13 and 30 hours respectively. Recently, a packing company has commenced operations in the valley, and has installed grading tables and packing sheds at suitable centres on the railway. To these packing sheds the fruit is delivered, and, through the company, is marketed under grade and trade mark.

There is much room for expansion in the Rio Negro, and probably there is more land uncultivated than under cultivation. Also, many of the uncultivated areas are under lucerne, a crop which is greatly favoured by those settlers who want quick returns. The future of the zone is focussed on fruit, and the old lucerne stretches are already being subdivided into smaller holdings for fruit cultivation.

The Rio Negro area has been described as the California of South America, and the time is not far distant when its products will be known in many lands and markets.

TROPICAL SOIL SURVEYING.

PART I.

(A)—Exploratory Surveys.

By F. Hardy.

The chief kinds of tropical soil surveys and their various objects may be classified as follows:—

i. Reconnaissance soil survey.

ii. Plant-geographical (broad ecological) soil survey.

iii. Specific physiological-ecological soil survey.

iv. Special-purposes soil survey.

The first two sorts are particularly applicable to the agricultural exploration of undeveloped tropical countries. The third is much more detailed, and is applicable to established agricultural areas, such as experiment stations, estates and farms, where greater knowledge of the fertility of the soil is required, and where the relationship between the growing plant and its soil environment is receiving experimental investigation. The fourth kind of survey is adapted to the needs of hygiene, sanitation and public health officers, and of civil engineers who are engaged in town planning, water-works construction and road building. It is also serviceable in the selection of materials for road building, pottery and cement making, and of factory sites where these materials may be elaborated.

In this article, it is proposed to consider the first two sorts of soil survey; the others will be reserved for consideration in future articles.

I. The Reconnaissance Soil Survey.

Agricultural and forestry reconnaissance of undeveloped tropical countries is closely linked up with topographical and geological exploration. Its objects chiefly concern the broad delineation of soil-types and of climatic regions suitable to the development of particular schemes of agriculture and forestry. Its methods are simple, and require no elaborate apparatus nor equipment.

The chief soil groups to be delineated are three in number, namely (1) *sedentary soils*, which occur directly overlying the rock from which they were derived, (2) *alluvial soils*, derived from weathered material that has been more or less recently transported by running water from its place of origin, and (3) *aeolian* or *dust soils*, whose immediate parent material has been transported by wind.

In continental humid-tropical regions, sedentary soils usually occupy the hill-country and the inland plateaux. The parent rocks underlying them may belong to various categories, for example, crystalline igneous rocks, volcanic ejecta, sedimentary rocks (both non-calcareous sediments and calcareous material, such as limestone), or metamorphic rocks, originally either volcanic or sedimentary, which have suffered profound alteration through subsequent earth-movement or vulcanicity. On the other hand, alluvial soils occupy low-lying flat lands, bordering the sea, or forming the margins of great rivers, or marking the sites of lagoons, lakes and swamps. They are generally the first to be developed under systems of agriculture introduced by settlers and colonists. Insular humid-tropical regions of relatively small area are usually volcanic or coralline in origin; they also are among the first to be occupied and developed by settlers. Finally, aeolian types of soil are generally confined to continental areas where arid desert conditions have prevailed for long periods of time. Vast expanses of soil of this sort occur in the Sudan, in China and Thibet, and in the south eastern Steppes of Russia. The first information which the reconnaissance soil surveyor must acquire, therefore, concerns the broad classification of the parent material occupying the area undergoing exploration; this information is obviously geological rather than agricultural.

Recent soil investigation, notably that of the Russian school, has shown, however, that the geological description of the parent rock material is altogether inadequate to the proper characterization and identification of prevailing types of soil. It has proved that the effects of climate may outweigh the influence of geological composition in deciding the characters of the ultimate medium of plant growth. Climatic effects are the most profound in continental regions; their importance in soil genesis was only appreciated when soil exploration was pushed beyond the limits of the main centres of civilized agricultural activity and of specialized soil research.

It is necessary, therefore, that the reconnaissance soil surveyor should also acquire information regarding the variations of climate that occur within the area of exploration. This is usually a simple matter in so far as the extremes of climate are concerned, but there is need of the establishment of meteorological stations equipped at least with instruments for measuring rainfall, temperature and humidity, at various centres in all regions where land development is contemplated. The reconnaissance surveyor can usually at least decide how far broad climatic factors, such as rainfall and mean annual temperature, have obliterated the effects of geological composition in deciding the general type of soil that prevails. Further details can only be studied by methods which belong to the next aspect of soil survey work, which will now be briefly considered.

II. The Plant-Geographical Soil Survey.

This kind of survey involves three different means of approach, namely, (1) regional studies of vegetation, (2) soil profile studies, and (3) surface-soil examination. Regional vegetation studies are largely botanical in aspect. They involve the identification and mapping of the main types of vegetation that occur within the area surveyed. The methods employed have been comprehensively described in a book published in 1926 by the British Empire Vegetation Committee, under the editorship of Dr. A. G. Tansley and Dr. T. F. Chipp.

One of the most successful methods of regional vegetation mapping consists in the clearing of traces or narrow strips of land along regularly disposed lines traversed by means of compass bearings. The composition of the vegetation is then determined along each of these traverses by a systematic identification of individual plant forms occurring within a belt bordering the trace (or its off-sets), the data being immediately recorded on a chart. Subsequent analysis of the data furnishes reliable and unbiassed information regarding the distribution and association of the various plant species, and leads to the delineation of areas within which the factors controlling plant-growth are presumably identical. The method is one which is nowadays widely used by forestry officers in undeveloped tropical countries. Its bearing on the economics of timber production is obvious, but unfortunately, its possible application to the wider problem of land utilization is seldom stressed. There appears to be a need of closer co-operation between the forestry officer and the soil surveyor. It is admitted that the forester can scarcely combine the functions of both, but there seems to be no reason why competent soil surveyors should not accompany forestry officers in charge of traverse parties who are exploring uncharted country, at least in the initial stages of a survey. The methods employed by such soil specialists would largely consist in the examination of surface soils, and in the description of sections such as may be encountered at river-crossings, and in occasional pits dug at various places as opportunity allows. At a later date, when the analyses of botanical data are available, the soil surveyors may revisit the areas and select sites for the excavation of deep pits, where the soil profile may be described down to the parent rock, and if necessary, sampled for subsequent examination in the soils laboratory. It is not essential, however, to collect large numbers of soil samples during surveys of this sort. Indeed, it may often not be feasible nor advisable, particularly if the scene of operations lies some distance from headquarters, and if transport facilities are inadequate. Much can be learnt by the application of simple soil re-agents, such as hydrochloric acid for testing the occurrence of carbonates, and a portable outfit for roughly measuring soil acidity by means of indicators. In all cases, however, the appearance of the different soil layers or horizons which a profile usually displays should be fully described, and the thickness of each layer measured and recorded. The description should include such features as the presence or absence of soil organic matter, root penetration, moistness, colour, structure and texture, or degree of sandiness or of clayiness, gauged by rubbing some of the soil between the fingers.

Profile study also furnishes valuable agricultural evidence of the *drainage conditions* within an area. These conditions frequently enough impress themselves on the natural vegetation ; their incidence is thus often revealed during the regional botanical survey. In some instances, definite evidence of the average depth of the water-table may be obtained in soil profile study, for water-logging sometimes impresses a characteristic mottled appearance, or a marked blue-grey colour on certain sorts of material exposed in profile pits. It may be necessary in important cases to revisit the site of a pit on more than one occasion throughout a climatic season in order accurately to measure the fluctuations in sub-soil water level, or even to initiate definite drainage studies with the aid of vertically sunken pipes.

For the purpose of deciding the relative importance in soil formation of geological composition and climatic agents that control rock decomposition and weathering, it is necessary to examine and to sample in some detail the layers immediately overlying the unaltered parent rock. The mechanism and results of rock decomposition are by no means thoroughly understood, especially in humid tropical regions, and no soil survey of the type herein described is complete without some reference to the fundamental facts of soil genesis.

Agriculturally, the broad ecological soil survey from the point of view of the plant-ecologist, should have considerable value in all schemes of land development. Its importance can hardly be overstressed in these days of rapid colonization and agricultural extension. Its thorough prosecution and appreciation by agricultural departments should prevent recurrences of wasteful procedures such as have figured only too largely in the history of soil exploitation.

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FRUIT AND VEGETABLES.

The Development of a Fruit and Produce Trade between the British West Indies and Canada.

By G. Evans, M.A., C.I.E.

In this article it is proposed to relate briefly the events that have led up to the present movement that is taking place towards developing an export trade to Canada in fruit and vegetable produce from the eastern group of British Colonies in the Caribbean area. The present position will be described and mention will be made of some of the steps that are being taken by the Governments of the several Colonies concerned, in order to develop this trade and establish it on a sound footing.

The Canada-West Indies trade agreement of 1925 did much good by directing the attention of primary producers to the possibilities of the Canadian market Before the War spasmodic attempts had been made to establish an export trade of fruit with Great Britain. For example, Barbados* was developing a promising industry in "Governor" bananas and mangoes and in 1913-14 exported 4,734 bunches of bananas and 194 crates containing 16,297 mangoes. The War, however, naturally caused a disruption in the schedule of sailings of the Royal Mail steamers which then served the British West Indies and this development came to an untimely end. In fact, it may be stated that as a general rule, the uncertainty of the steamer services seems to have been the cause of many of the failures in this direction that have taken place in the past. One result of the 1925 trade agreement was the construction by the Canadian Government of a modern line of steamers to deal with and develop the trade between the Dominion and the British West Indian Colonies. These steamers came into operation at the beginning of 1929 and have carried on a regular and punctual fortnightly service with all the Islands on the eastern route between Bermuda and British Guiana, Georgetown being the terminal port. The effect of this service has been to direct the attention of agriculturists in these Colonies towards the possibilities of supplying Canada with some of her needs in the matter of fruit and vegetables, and the various Agricultural Departments have been carefully investigating the position of laying plans for furthering production on a firm basis.

The development of this trade was one of the subjects that was discussed in great detail at the West Indian Conference of Agricultural Officers which was held at the Imperial College of Tropical Agriculture in Trinidad, under the Chairmanship of the Principal, and which was attended by representative officers from the College staff and the Agricultural Departments of British Guiana, Trinidad and Tobago, Barbados, the Windward and Leeward Islands, and Bermuda. The discussion was strengthened by the presence at the Conference of two gentlemen who are prominent in the Canadian Fruit and Produce Trade, viz.: Mr. J. A. McBride, General Manager, Fruit Importers, Ltd., Montreal, and Mr. F. E. Holloway, President of the Mutual Brokers, Ltd., Montreal. The advice given by these two gentlemen with regard to the requirements of the Canadian market proved of the greatest value, since not only did they clearly demonstrate that there is a definite market for West Indian produce of this description, but they also clearly pointed out that much will depend on the way in which the actual producers in these Colonies face the situation. In the first place they pointed out that all fruit and vegetables shipped to Canada must be properly grown, picked, graded, packed, marked and inspected. The quality, grade and package must compare as favourably as possible with those adopted by the United States shippers, if a footing in this market is to be established. They further suggested the appointment of a representative in Canada to work as a liaison officer between the West Indian shippers and Canadian importers, and expressed the desirability of undertaking an active advertising campaign in Canada for the purpose of making known the excellent quality of West Indian products. In this connection, it is hoped that the proposal to establish a Canadian Trade Commissioner for the West Indies, which seems likely to result as the outcome of the West Indian Trade Conference which has just completed its deliberations in Trinidad, will have the desired effect of advertising these products at any rate in the initial stages of development. Valuable information was also obtained of the particular classes of produce that are likely to be in demand and which will not conflict with Canadian grown produce. So far as vegetables are concerned it was pointed out that cabbages and turnips are already exported by Canada, and that carrots and onions are in little demand. It is of little use wasting time on these products, therefore, and the same theory probably applies to lettuces owing to difficulties of production and handling. The total imports of sweet potatoes into Canada are large but owing to the low price at which they can be obtained in districts close at hand, it would possibly be difficult for the West Indies to compete. On the other hand tomatoes are likely to develop into an important trade and can be grown in the West Indies and placed on the Canadian markets in the winter months when supplies from elsewhere are short. Other vegetables that can possibly be developed, though to a smaller degree, are egg plants, cucumbers, and string beans.

As regards fruit, it was pointed out that a good market exists for grape-fruit in Montreal in the summer and autumn, but supplies must be large and 80 and 96 sizes are popular. There is a regular trade in oranges throughout the year, but the demand for limes is only gradually being created. The present West Indian system of

* Annual Report of Barbados Agricultural Department, 1913-14.

packing in barrels is unsuitable and limes should be put up in boxes with the number of limes marked on the outside. Mangoes and avocado pears are not yet properly appreciated or understood, and should be shipped in small, attractive, and well ventilated cases to start with. The first consignments of avocado pears from the West Indies were shipped too ripe. Many other facts emerged from this discussion which was a valuable one to the agricultural officers attending the Conference, as the absolute necessity for conforming to market requirements was emphasised and the need for high quality and uniformity of produce and packages was made obvious. A definite attempt is now being made to get the different islands to adopt throughout the type of packing case that has proved suitable in Bermuda for shipping tomatoes and other vegetables, and it is hoped that standardisation in packing citrus and other fruits will follow as a natural sequence.

It will at once be realised that the business of establishing an export trade in these products is a complicated one, and will have to be tackled systematically. It cannot be established in a year and will have to be gradually built up. In the case of vegetables the suitability of the locality has first to be tested, and then seed of the best commercial varieties tested and arrangements made for seed distribution. The peasants have to be educated and organised and this means the establishment of Peasant Bureaux. Great care has to be taken in the preliminary stages, as the confidence of the small producer is not easily gained and can easily be lost by a false step.

In the case of fruits, the process is naturally longer, since the trees take longer to come into bearing and the question of the supply of plants of approved varieties for planting up orchards is a problem in itself. Each of these Colonies has, however, an old established Botanical Garden or Experimental Station in charge of an Agricultural Superintendent or a Curator, and these serve as the natural *foci* for the movement towards organisation and as distribution centres for approved seeds or planting material.

Although the first of the new ships of the Canadian National Steamships Company only passed through at the beginning of 1929, satisfactory progress has already been made and it may perhaps prove of interest to record what has already been achieved in the various Colonies in the eastern Caribbean area that hope to participate in this trade.

Of the Leeward Islands, the small island of Montserrat leads the way so far as vegetable production is concerned. This Colony is happy in possessing an industrious and virile agricultural population. The chief product is Sea Island Cotton but parts of the Island are proving to be particularly suited to the cultivation of tomatoes and to a lesser extent other vegetables. The Curator of the Botanic Gardens recently visited Canada in order to acquaint himself with market conditions. A Peasants' Bureau was started in August, 1929, and there was thus some degree of organisation already in existence by the time the Canadian National Steamships boats arrived. A depôt and temporary packing shed was started in December, 1928, and between that date and the end of March, 1929, 987 crates of peasants' tomatoes were graded and despatched, 720 crates going to Canada and realising £221 12*s.* 8½*d.*, the rest being shipped to Barbados and other islands. This year (1930) further developments have taken place and proposals are on foot to build a proper packing shed and erect a small pre-cooling house. In the first four months of this, the second year, 3,500 crates of tomatoes, 111 of carrots, 3 of egg plants, and 41 of limes have been shipped to Canada. Peasants bringing their tomatoes into the Bureau are paid two cents per pound on delivery and a second payment is made after all account sales are received, and the proceeds divided *pro rata* among the growers. The average price per pound of tomatoes received by peasants is four cents net. Overhead charges can be substantially reduced with greater experience, and this will mean an increased price to the grower.

In St. Kitts, experimental trials with tomatoes have been conducted by the Agricultural Department, and steps have been taken by the Government to convert the old market into a Fruit and Vegetable Packing Depôt. The site is a good one and is close to the site of the proposed cold storage plant. For the first few years, packing and grading will have to be undertaken by the Agricultural Department and the same holds true in the case of most of the other islands. In Nevis a land settlement scheme for peasants has been prepared and a site and building have been earmarked for a Fruit and Vegetable Depôt, and funds have been provided to enable the work to go forward at once. In Antigua tomato trials are proving satisfactory and it is hoped to start a Government Packing Shed by the end of the year.

All these northern islands are chiefly concerned with the tomato and vegetable trades, but Dominica and St. Lucia are wetter and are turning their attention to fruit. In Dominica organisation was started earlier than in the other islands, and a Peasants' Information Bureau was opened in July, 1926. Limes are the main fruit crop, but have latterly been suffering from Wither-Tip and Red Root diseases, and the attention of the planters has naturally been drawn to the possibilities of other fruits. The island is well suited to the production of grape-fruit and oranges, and capital has recently been attracted from outside and consequently larger areas of oranges and grape-fruit will shortly be developed. There are about 52 acres of grape-fruit in bearing now and about 100 acres in all, quite apart from considerable areas of oranges, and, of course, a large acreage under limes. The Botanic Gardens are the centre of plant distribution and are doing work which will have marked results in the near future. The policy is adopted of only sending

out plants of the best commercial types (*e.g.*, Marsh seedless) budded on deep rooted stocks, and 10,000 such plants have been distributed to date. During the current year 1,734 cases of grape-fruit have been shipped to Canada with smaller consignments of oranges, green limes and other fruits. As the new areas came into bearing the amount available for shipment will rapidly increase and 10,000 cases of grape-fruit within the next two or three years is a possibility. The Imperial Government has sanctioned a loan for the erection of a proper packing shed equipped with machinery for cleaning, drying, polishing and sizing and for the construction of a pre-cooling plant. Transport difficulties have prevented much of the fruit arriving at the shipping port in the past year, but it is hoped to gradually get over this difficulty.

St. Lucia has a somewhat similar climate to Dominica and attention is also being directed to fruit. The work of organisation has only recently commenced and a Fruit Growers' Export Association was only initiated in July, 1928. What is now required is the establishment of a Government Fruit Packing Shed, and a scheme has now been prepared and submitted, as it is felt that without some proper arrangement of this sort much of the effort that has already been put forward by the Agricultural Department will be wasted and real progress will be impossible. The Agricultural Department has done much pioneer work with oranges, mangoes, and avocadoes, and has gained much useful experience in testing the English, Canadian, and Bermuda markets. Mangoes do well in the island and the "Julie" variety in particular has proved suitable. Avocadoes have not given such good results, but this is owing to the variable forms of the fruit that have been shipped. The best types properly packed and picked at the right stage have, however, realised good prices. Over £4,000 worth of fresh fruit was exported last year, and last year 48 crates of grape fruit, 116 of oranges and 73 of avocadoes, together with small consignments of mangoes, tangerines and cucumbers were sent to Canada to test the markets. At this stage, therefore, work in St. Lucia is still in its infancy. The Agricultural Department is hard at work raising and issuing plants of approved commercial varieties of mangoes, grape-fruit and avocadoes, and at the same time the Government is contemplating a land settlement scheme for peasants, with fruit as a main crop.

In St. Vincent a Government Fruit and Vegetable Bureau was started in July, 1929. This island already grows a good deal of fruit, but much of it is not of first rate shipping quality and a good deal of steady work will be necessary by the Agricultural Superintendent and his staff in the way of raising and supplying plants of good varieties, and of encouraging the growers to produce fruit of the desired quality. This island, like Montserrat, and the other northern islands also appears suited to tomatoes and some of the other vegetables, but is not quite so favourably situated for the Canadian market as it is further south and therefore several days further away from markets. St. Vincent shipped last year 118 crates of mangoes, 363 of avocadoes, 148 of grape-fruit, 193 of limes, 56 of oranges, and 430 of tomatoes.

Grenada has always been regarded hitherto as mainly concerned with cocoa and nutmegs, but the coming of the Canadian mail steamers and the low prices of their main products have directed the planters' attention to the possibilities of the fruit trade. A scheme for the establishment of a Fruit and Vegetable Bureau to be financed by a loan from the Colonial Development Fund has been elaborated and the Secretary of State has telegraphed his approval and it is now proposed to erect a Packing and Grading Shed in the vicinity of the Power Station at the capital town, and it is proposed to make trial shipments of tomatoes at the fall of the year.

Trinidad, on account of its size, is an important factor. It has been well known that this island can grow citrus and mangoes to perfection. A Citrus Growers' Association was formed over two years ago and had the result of giving a decided stimulus to grape-fruit cultivation. There are about 300 acres of grape-fruit planted but only some 35 acres in bearing as yet. The quality is excellent. The Agricultural Department has adopted the very wise policy of only countenancing the planting of first-class commercial varieties, budded on deep rooted stocks which in the main are "sour orange." Their policy, which is at one with progressive planters of this island, means that Trinidad is aiming at turning out a really first rate quality of grape-fruit and this is bound to have beneficial results as soon as the areas planted come into bearing. The Trinidad Government has now been approached for the construction of a properly equipped packing shed, and a loan of £5,900 has been applied for, which is to include advances for the first year's operations. A site has already been selected near the Customs House in Port-of-Spain. The establishment of this packing shed should act as a great stimulus and do much to put the fruit industry on a firm basis. In addition to grape-fruit, there appears to be direct opening for oranges, mangoes and other fruits, and all will be handled in the new packing shed. Last year Trinidad exported 807 cases of grape-fruit and nearly one and a half million oranges.

In concluding this brief account of the position in the various Colonies on the eastern route of the Canadian National Steamers, no mention has been made of Barbados and British Guiana, but it is known that the Agricultural Departments in both these Colonies are taking definite steps and hope to develop the production of fruit and vegetables with the object of participating in the Canadian trade.

Owing to the number of different Colonies and the relatively small size of so many of them, it will be readily realised that the difficulties in establishing a trade in this class of perishable

produce of the desired uniformity and quality and in sufficient quantity to attract good buyers in the Canadian markets, are considerable.

The problem is a complicated one and it is obvious that as the trade develops provision will have to be made for the utilization of cull and off-size fruit, and fruit that comes into the shed in between the calls of the steamers. Some of this produce can be held if the pre-cooling chambers that are already engaging the attention of several of the Governments, are established. The best way to utilise the rest of the surplus produce will, however, be to put up small canneries and this was a possibility that was also the subject of discussion at the Conference of Agricultural Officers that was held in Trinidad last January.

The main object in view can only be achieved gradually, and disappointments and setbacks are bound to occur from time to time. A perusal of this article will indicate that there is hope that a successful issue will eventually be the outcome because the various Governments are all working steadily along the same definite and well considered lines. The growers are being given all the assistance possible in the way of information, a steady policy of supplying seeds and plants of proved qualities is being adopted, and the necessity that all export produce should go through a single packing shed, and so conform to definite standards of uniformity as regards grade, quality and packages, is strongly realised and is being insisted on.

The time for establishing the trade could not be more opportune. There is a slump in prices of all the main agricultural staples produced in this island and planters are only too anxious to cut an alternative crop that possesses a reasonable hope of benefit. On the other hand, the Demerara Government is anxious to expand the trade with the West Indies and has indicated their desire to effect this by the very practical method of turning over tariff rates in favour of this island. The final success of the scheme will, however, depend on the energy and skill of the West Indian planters and in the closest co-operation and goodwill between the producer and shipper in these islands and the buyer and consumer in Canada.

EMPIRE TOBACCO.

In a summary by E. E. Campion in *The Times Trade and Engineering Supplement* (24th May, 1930), he states that the production of Empire tobacco continues on a sound basis. The percentage of Empire clearances for manufacturers in the United Kingdom, compared with total clearances from all sources in 1929 was 17.10 per cent., against 16.62 per cent. in 1928, and only about ten per cent. in 1925. It is recognised that in some parts of the Empire there has been over-production, but a restriction of crops is now taking place, and attention is being concentrated on quality, grading and packing, rather than on quantity. In Southern Rhodesia, for example, the yields of the last three years have been 17,000,000 lb., 24,000,000 lb., and in 1929, less than 6,000,000 lb. Some three years stocks of Rhodesian tobaccos are still in warehouses.

RATIONALISATION.

By

H. M. Leake.

Continued.

III.

The desire of all those engaged in production is stability; stability in the markets in which they purchase their raw materials and stability in the markets in which they dispose of the products of their enterprise. Only under such conditions are they in a position to conduct their business with reasonable assurance. In industrial enterprise the costs of production can be calculated with a considerable degree of assurance for, with the technique of industrial processes so well developed, a given supply of raw material can be depended on to yield with certainty a given output. In agriculture, matters are different. Here human endeavour plays a more subordinate part and it is nature that is the chief performer. The agriculturist may supply all those requirements which his knowledge and skill indicate to be necessary but it is nature which decides the extent to which he will reap his reward. Here is a form of insecurity with which the industrialist is practically unacquainted. Here is a fundamental difference between agricultural and industrial production of which any scheme of rationalisation must take cognisance. The implications arising from this difference require to be considered with some care.

Nature is a very wide and indefinite term and needs to be defined. As we use the word here, in its relation to agriculture, it includes all the non-human agencies that may affect the growth of the plant. It includes, therefore, all those natural physical phenomena which are summed up in the word climate and it includes, further, all those biological phenomena which are the outcome of the reaction of the crop plant to the living components of its environment. From the practical aspect a different classification is to be preferred. Nature may be said to be composed of two sets of forces, those which are, and those which are not, controllable by man. The line of demarcation is not sharp for the degree of control may vary with locality. Though it may not be possible to control rainfall, the effect of rainfall may in large measure be controlled; excessive rain by drainage and deficient rainfall by irrigation. In the latter case the extent of the control is limited by the available supply of water. The line of demarcation may also shift with time. With the progress of knowledge, means are found to control conditions formerly incapable of control. Research has indicated practical means for making many intractable soils tractable and it has done much to bring under control those vast numbers of pests to which crops and domestic animals are susceptible. Instances are too many, and too well known, to require enumeration.

Even when full allowance is made for the rapid extension of knowledge on these matters, there must still remain a considerable range of uncontrollable forces at work and stability in this field peculiar to agriculture can never be secured. The return will never be proportionate to the effort expended. Nevertheless, such stability as control may render possible is desirable, and for that control to be effective two conditions are essential; investigation, or research, which indicates the methods of control, and supervision of the application of those methods in practice. The practical bearing of this conclusion is, perhaps, better indicated if the subject is approached from a different direction.

In nature there occurs a community of organisms, both plants and animals, the various species composing which, have established an approximate balance under the particular physical conditions of the locality. That balance may, it is true, from time to time be upset but, broadly speaking, a position of stability is maintained in which each species occupies its allotted position. Into this state of equilibrium man enters as a disturbing factor. He clears the virgin growth and he plants his crops. The balance is upset and adjustment to the new conditions commences around a new centre of equilibrium. The unbalanced forces that come into play are many and various. Pests, both vegetable and animal, mainly fungi and insects, hitherto kept in check by a limited and scattered supply of their hosts or by other organisms to which they play the part of host, may find in the crop an acceptable substitute in which they may play havoc even to the elimination of the crop; for a crop is that rare product of unaided nature, a pure growth of a single species and offers a fertile field for the rapid spread of disease. Many crops, too, are exotics. They are brought from other countries and with them may be brought diseases which, being freed from the restraints which held them in check in their country of origin, run riot in their new home. These exemplify the biological forces that may be let loose by man's interference with the orderliness of nature. His action may also let loose physical forces. Injudicious clearance has only too often permitted the direct play of the elements, in particular, rain, to cause a rapid loss of soil and, with it, fertility to the injury of the crop. And that liberation of the physical elements reacts with the biological forces in as much as the soil is a vast biological laboratory. Clearance may, and often does, by the combined action of both forces, lead to the loss of humus and the deterioration of the physical condition of the soil.

These, in very brief outline, are the causes which, apart from seasonal variability, make for instability in agriculture. They are causes which have more than ordinary effect in the tropics. In an old country like England, which has seen centuries of cultivation, time has permitted the establishment of an equilibrium of which the crop and the various activities of man summed up in the word cultivation form essential features. Pests are still active but are hardly to be counted among the uncontrollable forces leading to instability. They cannot, perhaps, be eliminated but measures of control form a recognised part of the cultural process. There is little or no virgin growth to provide an inaccessible harbour and breeding ground for these pests. Cultural processes, too, have been evolved which maintain the fertility of the land under a system of continuous cropping and such processes are an integral part of the new environment.

Compare these conditions with those that prevail in a primitive tropical country. Primitive agriculture here consists in clearing an area in the natural growth, and planting the crop with little or no further preparation than is given by the fire used for clearance. What humus is left by the fire is rapidly destroyed by exposure to sun and rain and fertility is rapidly lost; so rapidly that in a season or two the crop is unprofitable, the land is allowed to revert to nature and a new area is cleared. Further, such clearings are mere islands in a sea of virgin growth which affords a safe harbour to all the pests to which the crop is liable.

Compare tropical conditions, not with those of an old country like England but with a new country in the temperate zone like Canada, South Africa or New Zealand. Again the tropics suffer in the comparison. The higher temperatures prevalent develop an activity, both organic and inorganic, unknown in the temperate world. Disease passes more readily to the epidemic form; bacterial activity in the soil is more intense while, on the inorganic side, soils under excessive humidity soon become acid or, under arid conditions, alkaline. Cultivation of tropical soils is an art requiring a maximum of skill and knowledge if a healthy plant is to result. And a healthy plant should be the first aim of the cultivator, as is becoming daily more apparent, in health lies the first step towards freedom from disease. Immunity is a relative term characteristic, perhaps, of a particular race but liable to break down when conditions are unfavourable.

A further division of the controllable forces injurious to crops may usefully be made into those which are, and those which are not, transmissible in space. It is clear that a cultivator who neglects the proper cultivation of his crop and thereby secures a reduced yield is the main sufferer. But he is not the only sufferer. Indirectly there is an injury to the community in that there is a reduction of the total wealth by the amount by which the crop falls short. If, however, he fails to cultivate the crop at all, or if, having raised a crop, he allows it to become infested by such pests as the crop is near to—and, because it is weakly it will fall a ready prey to disease—and takes no steps to control those pests though the methods of control are well known, he becomes a direct danger to his

neighbours. On both grounds, and emphatically on the latter, there is justification for control to ensure that a proper standard of cultivation is maintained and especially to ensure that disease is kept within bounds.

The same conclusions as to the need for control are reached from another line of argument. Most of the products derived from tropical exchange cultures require a greater or less amount of preparation to fit them for the market. Further, the price realised depends in the first place on quality, in the second, on uniformity and maintenance of standard from one consignment to the next. Two points are involved. Quality and uniformity are both related in a degree varying in different crops, but in some degree to the uniformity of the culture. A mixed culture composed of a number of different races or even species cannot yield a uniform product. Consequently a large effort has been made to establish 'pure' cultures, cultures composed of only one variety, of one race or even, where vegetative propagation is concerned, of a single plant. Work along these lines on tropical plants lags behind that on plants of the older temperate countries but has, nevertheless, led to a wide cultivation of crops having a greater or less approach to purity. Cotton has been subjected to such intensive breeding and selection for a number of years; in many countries cane cultivation is limited to at most a limited number of races vegetatively produced; rubber and cacao are being subjected to the same process; the intensive study of coconuts and palm oil are being undertaken along similar lines. It is an inevitable application of the recent advances in genetical knowledge for the more adequate fulfilment of market requirements and, in some cases even, for the maintenance of the cultivation of a crop in certain localities. In Egypt, for instance, much of the genetical work has been directed to the maintenance and improvement of the quality of staple in cotton while in South Africa the main problem has been to obtain a Jassid resistant type without which cotton cultivation appeared to be doomed as a commercial proposition.

But such pure, or relatively pure, cultures require greater care. In short season crops raised from seed, the seed supply requires to be rigidly guarded and, where cross fertilisation is normal, an intricate organisation for the maintenance of purity is essential. This must be an organisation with power to ensure that no extraneous variety is grown in the vicinity of the crop supplying the seed, power to see that none but seed of guaranteed purity is sown. Improvements of this nature entail control if the potential benefits are to be realised in practice.

If, however, market requirements make the general adoption of such 'pure' cultures inevitable, there are not lacking disadvantages. There is no doubt that mixed cultures are best adapted to a primitive type of agriculture for they provide a form of insurance. In the precarious tract of Bundelkhand the common mixture of wheat, barley, mustard, linseed, and gram offers an extreme case in which, whatever the season, the cultivator is likely to reap one. The 'pure' culture has no such flexibility. It aggravates the risk and it is more liable to fall to disease in epidemic form. The control which is essential for the check of disease becomes doubly important where pure cultures have been widely introduced.

In many cases, however, quality as well as uniformity is a product of other causes than purity of the crop. Where the primary product requires preparation for the market the quality of the marketable form may depend on the care exercised in the preparatory processes. Quality in this sense may result from the inclusion of foreign matter as impurities due to careless handling or even wilful adulteration. Here the quality may be restored at the expense of a cleaning process. Frequently, however, the preparatory process involves chemical or biological reactions which require skilled manipulation if a satisfactory product is to result; processes which admit of no remedy if carelessly conducted in the first instance. Typical of such processes are the curing of tobacco, the fermentation of cacao, the extraction of palm oil and the decortication of fibres. Here the loss of quality is permanent and may be accompanied by a loss of yield. The conduct of such processes by small and independent units must react detrimentally on the price received, for market prices tend to adjust themselves to the lower quality and the small producer of good quality will with difficulty secure the intrinsic value of his produce. Again, control is necessary if this source of depression of quality is to be avoided.

Rationalisation, using the word in its widest sense, that given to it at the World Economic Conference, "the methods of technique and organisation to secure the minimum of waste of either effort or material," demands control of tropical agricultural production, control which will secure the highest standard of cultivation, the elimination or suppression of disease and the skilled preparation of the product. In the narrower sense of the word which has been accepted in these articles, rationalisation makes the same demand. In the competition arising from the overproduction that is now characteristic of tropical agriculture no less than industry, only the efficient producer can hope to survive in the struggle.

To be continued.

PROBLEMS IN BIOLOGICAL CONTROL.

We regret that in the article entitled, "Problems in Biological Control," which appeared in our last issue, Vol. VII, No. 8, pages 215-219, the name of the author Mr. H. W. Simmonds, Government Entomologist, Fiji, was omitted.

COCOA.

World Production and Trade.

THE prices which cocoa producers throughout the world have received for this commodity have shown a marked decline during the past few years, and fears have been expressed in some quarters lest production may be developing at too rapid a rate. The problem is not new ; indeed it occurs in the case of almost every product in regard to which production is expanding, and especially where the period between planting and the first financial return to the planter is to be measured in years. But cocoa is perhaps of peculiar importance owing to the abnormal rate of expansion of the industry during the past two decades, and to the overwhelming share of the British Empire in world production.

A recent Memorandum* prepared by the Empire Marketing Board gives a statistical record of the trade in raw cocoa in recent years, with some indication of the general trend of consumption of cocoa preparations.

Production and Export.

The dominating feature of the cocoa producing industry has, of course, been the enormous progress made by the Gold Coast, which in 1891, made its first shipment of 80 lb. Since then progress has been extraordinarily rapid, and now this country produces about 45 per cent. of the world's total supply, with a cocoa area estimated at about 900,000 acres, carrying some 180 million trees.

The crop is grown entirely by natives, who, under the stimulus of high prices at the end of the war, rapidly increased their cocoa acreage. In later years, the increased production, from 1922 to 1924, is considered to have been largely due to improved transport facilities, as new roads and railways have greatly extended the area in which the production of cocoa is economically possible and also released labour formerly needed for head transport. It is believed that when new railway lines now in course of survey are constructed, further considerable new areas of cocoa will be opened up.

In interpreting the export figures, attention is called to the fact that the annual fluctuations observable are largely due to the arrangement whereby the figures relate to calendar years, whereas the main crop is harvested from October to January or later : hence a late season or (more often), the holding back of supplies by the growers or shippers may reduce the exports of one year and magnify those of the next. There appears, however, to have been a definite check in the regular increase since 1924. It does not seem probable that this is due to insufficient labour, and as regards the area of cocoa land, there are still fairly large areas untapped, in which considerable increases in planting are possible. As regards the possibility of a decline, it is generally considered that there is little probability of decreased production, for although the older farms are becoming exhausted, new areas can still be opened up, and labour tends to migrate from the outworn farms in sufficient quantity to reinforce the labour population to the point of maintaining the output. Indeed, any improvement in prices enough to make it worth while to harvest and export the crop, would doubtless result in a further increase in production and export. If problems of infestation, deforestation and soil exhaustion, all tending to operate with increasing power throughout the period of expansion of this industry, can be solved with some success within a reasonable period, it is certain that the Gold Coast will produce even larger quantities of cocoa in the future than in the past.

In this connexion, the Department of Agriculture of the Gold Coast has, for some time past, been engaged in a campaign to improve the rather low standard of Gold Coast cocoa, with the result that the product is now much nearer in quality to the finer sorts, than it was a few years ago.

Brazil takes second place to the Gold Coast in volume of production of cocoa. In 1926 the total number of cocoa trees in Brazil was estimated at about 130 million, compared with the 180 million in the Gold Coast. Most of the cocoa is grown in the state of Bahia, and the product is commercially known under this name. The best quality is usually regarded as only slightly superior to Gold Coast cocoa, and Brazil imports a considerable quantity of her home requirements from Venezuela, as her own product has not found much favour unless blended with a superior quality of cocoa. Some progress has been made in the introduction of Venezuelan *Criollo*, but the lighter yields of this variety are not tending to make it popular.

There seems no reason to suppose that cocoa production in Brazil will not continue to show an increase, in spite of certain handicaps which the producer has to bear in the shape of heavy taxation, high transport charges and scarce and costly labour. It is claimed that Brazil is ideally situated for the production of cocoa, and land recently opened up is said to be better suited for cocoa cultivation than any to be found in Bahia. In spite, therefore, of the adverse factors militating against the development of the industry, it seems likely that production will continue to increase.

In Nigeria, conditions appear to be very similar to those in the Gold Coast, with the exception, perhaps, that in Nigeria, there is more competition from other crops. Increase in the past few years has been considerable, both in quantity and quality ; this latter may be largely attributed to the work of the Government fermentaries and to the system of inspection of cocoa for export which the Government has recently instituted. There seems little doubt that during the next twenty years, given an

* COCOA.—*World Production and Trade.* E.M.B. 27. H.M. Stationery Office. Price 1s. net.

adequate development of transport facilities, and sufficient inducement to extend production, cocoa cultivation in Nigeria will increase enormously. Furthermore, any depression in the palm nut and oil industry, such as might follow from the development in the Dutch East Indies, would probably divert attention from the oil palm towards cocoa, and thus accelerate the rate of increase.

The Dominican Republic produces what is known commercially as "San Domingo" cocoa, and on a scale which brought it in 1927 to the fourth position among the cocoa producing countries of the world. Since then the figures have shown an appreciable falling off.

The exports of raw cocoa from the French Colonies and Mandated Territories are not as yet very considerable. Up to the outbreak of the War, the two main French producing Colonies were Martinique and Guadeloupe, but while these Colonies have recently been producing rather less cocoa than earlier in the century, the French African Dependencies have shown substantial increases. In the Ivory Coast, French Togoland, French Cameroon and Dahomey, the French authorities are making determined efforts to stimulate the production of this crop. A service of travelling inspectors who are available for giving advice to native growers has been established, and free distribution of cocoa plants is being made from Government nurseries, which have been opened at various centres. It is worth noting that cocoa produced in the French possessions enjoys a substantial preference over other cocoas in the French market, so that practically all the exports from these parts are taken by France herself.

Trinidad heads the list of countries which produce what is known as "fine" cocoa, a quality which is very largely used for blending with the more ordinary types such as are produced in the Gold Coast. The crop is cultivated both in estates and by peasant proprietors and a great deal of attention and care has been taken to preserve the reputation of the crop for its uniform good quality. The recorded area under this crop has shown a continuous decline and in 1928 the area had fallen to less than 150,000 acres. Nevertheless, production has been fairly well maintained and the average total export for the years 1925-29 was above that of the quinquennium preceding the War. By reason of its quality, Trinidad cocoa has always enjoyed a substantial premium over the common types of cocoa, and it is only thus that it is able to compete in the world's markets, for costs of production are naturally high in comparison with those in West Africa and other countries producing "ordinary" cocoa. Reference may be made to the Cocoa Planters' Association of Trinidad, which is a co-operative society of planters for the marketing of cocoa, and which now markets as much as one-seventh* of the Colony's total output.

Net Exports of Raw Cocoa from Countries producing "Fine" and "Ordinary" Sorts.

	1909-13	1922	1923	1924	1925	1926	1927
Fine Cocoa.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
Venezuela	15,800	20,560	22,070	17,050	22,580	14,810	15,160
Ecuador	36,760	43,550	30,390	32,720	32,380	21,430	23,200
Trinidad	22,540	22,880	30,320	25,080	21,840	22,000	23,030
Grenada	5,330	3,640	3,890	4,270	3,660	4,170	5,020
Ceylon	3,540	4,160	3,040	3,470	3,440	3,240	4,040
Dutch East Indies ..	2,310	1,240	1,300	1,600	1,180	1,080	960
Jamaica	2,600	3,840	2,160	2,960	2,620	3,010	2,860
Costa Rica	280	2,060	4,190	3,620	4,080	5,230	3,370
Dutch Guiana	1,580	1,540	1,390	730	800	130	210
Other Countries	4,560	6,380	4,280	6,070	5,990	7,240	7,150
Total	95,300	109,850	103,030	97,570	98,570	82,340	85,000
Ordinary Cocoa.							
Gold Coast	34,350	159,300	197,660	223,330	218,150	230,840	209,910
Brazil	31,140	44,560	64,300	67,780	63,510	62,310	74,350
Nigeria	3,320	31,260	32,820	37,200	41,070	36,000	36,090
San Thomé	34,080	20,350	12,710	21,630	20,530	12,270	16,500
San Domingo	17,990	18,690	19,520	22,780	23,110	19,770	26,090
Haiti	2,440	1,970	1,990	1,620	1,510	2,160	1,600
French Equatorial and West Africa	4,170†	9,460	10,380	15,210	15,710	17,330	23,400
British Cameroons ..	—	3,210	1,640	3,170	3,640	3,100	3,120
Fernando Po	3,590	5,920	7,090	9,480	5,870	5,670	5,870
Other Countries	1,750	4,510	5,180	6,560	6,930	6,900	7,080
Total	132,830	299,230	353,290	408,760	400,030	396,350	404,010
Grand Total ..	228,130	409,080	456,320	506,330	498,600	478,690	489,010

* This is now nearly one-fifth.—Editor.

† Includes pre-war exports from territories now under British and French mandates.

We have only space to mention lastly Ecuador, which has fallen from its once premier position as producer of "fine" cocoa and which is still showing a decline. Disease, the dread Witch Broom, and the introduction of poor types which affected the quality of the product are alleged to be responsible. Many plantations have been abandoned, others have been planted with bananas, coffee and other crops, and it appears probable that production will continue to decline, until it ceases altogether.

The foregoing table shows the net exports of raw cocoa from producing countries, the diminishing output of the "fine" group and the astonishing increase in the production of "ordinary" sorts.

Consumption and Import.

By far the largest consumer of cocoa in the world is the United States of America, which imported no less than 170,000 tons in 1928, or more than the combined imports of its two nearest rivals, Germany and the United Kingdom. The consumption of cocoa in the States has more than trebled since before the War; prohibition and the high standard of living enjoyed by the people are major contributing factors to this state of affairs. This large demand is filled mainly from British West Africa, Brazil and the Dominican Republic. As will be seen below, import figures do not in all cases represent domestic consumption, as many countries re-export manufactured cocoa products, but it may be noted, that the whole of the import into the States is absorbed in the country and that very little is exported. Second in importance as an importer of cocoa is Germany, and upwards of 70 per cent. of her requirements are drawn from British West Africa, and here it is noticeable that of the total amount imported, the proportion of finer grades is very low, and that imports from the British West Indies show a pronounced decline. In the United Kingdom, consumption has very largely increased, though not at the rate shown by the United States of America; present day figures are roughly double those of 1913, the increase being from 27,000 tons to 55,000 tons in 1928. Statistics reveal that the proportion of Empire grown raw cocoa has increased, and that the actual supply from foreign sources has declined. Of the total of 94 per cent. for which the Empire is now responsible, British West Africa supplies 87 per cent. and the British West Indies six per cent. Of Empire consumers, Canada shows a fairly steady increase during recent years, and it is of interest to note that direct imports from the British West Indies have rapidly increased since the trade agreement between the two countries in 1925, under which British West Indian cocoa is imported into Canada duty free, and the provision of better shipping facilities. Mention must be made of Holland as an important cocoa market. Her imports almost equal those of the United Kingdom; she re-exports a considerable quantity of raw cocoa, and is the largest exporter of cocoa powder and cocoa butter. As has been mentioned above, France largely draws on her own Colonies for her increasing demands, and she is one of the few importing countries which shows a marked decline of importations from British West Africa.

The average *net* world imports of raw cocoa are shown in the table below.

	1909-13	1919-21	1922-24	1925-27
	Tons.	Tons.	Tons.	Tons.
U.S.A. ..	58,400	139,600	163,300	177,500
Germany ..	47,700	* 72,800	73,000	69,800
United Kingdom	26,900	57,900	48,700	54,700
Holland ..	24,600	30,100	36,000	43,100
France ..	25,500	43,700	39,200	37,100
Switzerland ..	9,100	11,600	5,500	6,900
Italy ..	2,100	4,900	5,600	7,200
Belgium ..	5,600	7,700	8,400	6,600
Spain ..	5,800	7,900	10,300	8,900
Czecho-slovakia ..	—	2,700	6,300	7,200
Canada ..	1,900	7,000	7,600	6,600
Other Countries ..	17,900	25,100	27,200	40,900
Total ..	225,500	411,000	431,100	466,500

General Conclusions.

The dominating feature in the cocoa trade in recent years is thus seen to have been the extremely rapid development of the industry in the Gold Coast, Brazil and Nigeria, which have outstripped the older producers such as Ecuador, San Thomé and Trinidad. That this process will continue is clear from what has been said about prospects in Nigeria, and about the very determined efforts the French are making to increase the production of cocoa in their West African Colonies. The success of cocoa growing in West Africa generally has been due not only to suitability of soil and climate, but to the fact that it appeals to the native as an easy crop to grow. He is able to establish his cocoa with hardly any capital expenditure, and he is able to subsist, until his trees begin to bear, on the native crops which are inter-planted in the cocoa. In consequence, the planters in the more highly civilised countries of South America and the West Indies are finding it difficult to meet the competition of cocoa produced under these conditions, and, in fact, at the present day, their position is only maintained by the fact that they can still claim a premium for their product in consequence of its superior quality. All the West African Colonies and Brazil produce what are known as "ordinary" cocoas, and since these first came into prominence, they have been looked upon mainly as bulk cocoas which it was necessary to improve by blending

* 1920-21.

with finer types. The position, however, is changing, as will be seen from a comparison of prices for the last four or five years, which clearly shows that the price margin between "Trinidad" a "fine" cocoa, and "Accra" an "ordinary" cocoa, has been gradually narrowing. In 1924, Gold Coast fetched 61.5 per cent. of Trinidad, whereas, in 1928, it was as much as 86 per cent. Part of this change may be ascribed to an improvement in the quality of West African cocoa, part to improvements in manufacture which have enabled the proportion of "fine" cocoa needed to produce a particular quality to be gradually reduced, in some cases, to the point of dispensing with it altogether, and a part undoubtedly, to a gradual deterioration which is taking place in the finer cocoas, as superior types such as "Criollo" become crossed with the inferior "Forestero" types. How far this change may be expected to continue is open to question, but it seems likely that in general, it will still be necessary to use some fine grades for the purpose of producing superior kinds of chocolate and chocolate confectionery, and it may be confidently anticipated therefore, that such cocoas will continue to enjoy some premium over the ordinary grades. At the present time, fully 23 per cent. of the imports into Switzerland, about 20 per cent. of those into the United States, 16 per cent. into France and Italy, and 10 per cent. into the United Kingdom can be definitely classed as fine cocoas. It is further understood that the manufacturers of high-class chocolate and confectionery are maintaining their position, and that the demand for their products seems assured, so that the position need not cause undue despondency, and it should always be remembered that the results of research work now in progress and under development, may be expected to increase the yield per tree and lead at once to a lowering of the cost of production.

As regards the production of "ordinary" cocoas, there can be little doubt that a considerable increase may be expected. We have seen how production has steadily tended upwards in the last five years, and there can be little doubt of the capacity of the world to absorb very much larger supplies of cocoa than at present. Those who wish to be pessimistic may point to a recent slowing of this rate of increase as an indication that the saturation point is approaching. It is certain that contributory causes to this slowing up of demand, which is noticed in certain countries, have been the increase in the use of tobacco by women, dieting, and the increas d consumption of fruit, and possibly, the greater variety of choice confectionery of other kinds. Those, on the other hand, who are optimistic, will point to the fact that there are large areas in Europe, in Russia, and throughout Asia, where the consumption of cocoa preparations are at present almost negligible, and will declare that there is no cause for any apprehension that demand, potential or actual, is anywhere near the limit.

R. C. W.

ST. VINCENT COTTON.

For some time past the question of maintaining the standard of Sea Island cotton in the British West Indies has been a matter of serious consideration. This is particularly the case in St. Vincent, and the recent enquiry that was held by the Commissioner of Agriculture with the collaboration of Mr. E. E. Cheesman, Professor of Botany and Genetics at the College, has led to the conclusion that additional help is essential if the standard of purity of the present types is to be maintained and if further improvements are to be effected.

It will be recollected that a Cotton Breeding Station was formerly maintained at St. Vincent under the charge of Dr. S. C. Harland in the first instance. He was succeeded first by Dr. T. G. Mason and later by Mr. L. H. Burd and on the latter's vacation of the post five years ago, the Station was closed and the work of maintaining the standards of seed cotton devolved on the Superintendent of Agriculture of St. Vincent.

Experience has now indicated that this additional work is proving beyond the capacity of the small staff of the St. Vincent Agricultural Department, since the activities of the Department have extended in other directions, and additional calls are being made on the time of the Agricultural Superintendent. Representations have accordingly been made to the Empire Cotton Growing Corporation and this body has generously agreed to re-open the St. Vincent Cotton Station and to bear the costs of the establishment, the St. Vincent Government providing the land, and the necessary quarters and offices, which are situated in the proximity of the cotton ginnery and station.

Mr. S. H. Evelyn has been appointed Officer in Charge of the Station and will shortly take up his duties in St. Vincent. He is a diplomate of the Imperial College, completing his course in 1925, and has since then been employed in the Barbados Agricultural Department as Assistant Geneticist and Plant Breeder.

A further development has been made in the arrangements whereby Dr. S. C. Harland the Geneticist at the Cotton Research Station in Trinidad, will act as adviser on cotton breeding matters to the College Advisory Department in the West Indies. Under this arrangement, Mr. Evelyn, who is on the staff of the Advisory Department so far as administration is concerned, will come under the control of Dr. Harland as regards his technical work. Dr. Harland's extensive knowledge will also be available to the Commissioner of Agriculture for service in the other cotton growing islands, such as Montserrat and St. Kitts, when required.

It is believed that these new arrangements, which have become possible through the generous action of the Empire Cotton Growing Corporation, will have a very desirable effect in maintaining the purity of the existing strains of Sea Island cotton in these islands, and will also serve to further encourage growers in maintaining their standards of quality.

G. E.

ELECTRICAL CONDUCTIVITIES OF SOIL EXTRACTS.

By C. H. WRIGHT, M.A., F.I.C.,
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PURE WATER has a very high electrical resistance, or, in other words, a very low conductivity. The resistance offered by a cube of a conductor having sides 1 cm. long is called the specific resistance, and the reciprocal of this is known as the specific conductivity. The specific conductivity of pure water is less than 1 millionth of a mho (reciprocal ohm), and the purer the water the lower the conductivity. On adding to water any electrolyte the conductivity is increased, but the increase is not the same when equal weights of different electrolytes are added to the same quantity of water, owing to the different velocities of the ions. If, however, solutions contain the same ions, and have a similar composition, the more concentrated the solution, the higher the conductivity. It is thus possible by measuring the specific conductivities of natural waters, irrigation waters and soil extracts to find their relative concentrations. The specific conductivities of 1 to 5 extracts prepared from soils in Nigeria have been found to vary from 163 to 12 millionths of a mho.

Electrical conductivities are measured by the Wheatstone bridge method. The apparatus in its simplest form consists of a wire 1 metre long, which is fixed above a metre scale divided into mm., together with a sliding contact. In one arm of the bridge is inserted a resistance box, and in the other arm is placed a conductivity cell containing the liquid under examination. To prevent polarization, an alternating current from a small induction coil is passed through the bridge, and a telephone is used as a current detector. The terminals of the secondary circuit of the coil are connected with the ends of the bridge wire ; and the telephone is inserted between the sliding contact and the junction of the resistance box and the conductivity cell. The determination is made by placing the liquid under examination in the conductivity cell ; when it has attained the desired temperature, a suitable resistance is inserted and the sliding contact is moved along the bridge until the sound in the telephone is at a minimum. The ratio of the resistance in the box to the resistance of the conductivity cell is then the same as the ratio of the two parts into which the bridge wire is divided by the sliding contact. It is thus possible to find the resistance of the conductivity cell ; but, in order to find the specific conductivity of the liquid under examination, it is necessary to determine the cell constant. This is done by determining the resistance of the cell at the same temperature when it is filled with an N/50 or N/100 solution of potassium chloride, the specific conductivity of which has been accurately determined at that temperature. In all determinations the cell and its contents must be maintained at a constant temperature, since the conductivity changes considerably with change of temperature.

Measurements of electrical conductivities of soils were made by Whitney and Means [7] with the object of finding the salt content of soils. A portable bridge for this purpose has been designed by the United States Bureau of Soils, and is described by Davis [3]. It is enclosed in a wooden box, and consists of a slide wire, a battery, resistances, a telephone and a cup to hold the soil material ; this cup is really a conductivity cell with a known cell constant. To determine the salt content of a soil, the soil is thoroughly mixed with water until the saturation point is reached. It is then transferred to the cup and its resistance is determined, after which the temperature of the contents of the cup is taken. From these data the salt content of the soil can be found from tables given by Davis [3]. The results are approximate only, but this method has proved to be very useful for rapid work in the field.

The electrical conductivities of soil extracts and soil solutions have been determined in order to find their relative concentrations ; thus, Burd and Martin [2] determined the conductivities of successive portions of the soil solution with the object of finding whether their concentrations were constant. More recently measurements of electrical conductivities of 1 to 5 soil extracts have been made with the object of measuring the fertility of the soil. This method is due to Atkins [1], who placed 10 grams of soil in a bottle with 50 c.c. of conductivity water (*i.e.*, water of low conductivity) and shook at intervals for 3 or 4 hours. The mixture was examined at intervals up to about a fortnight, or such lesser period as sufficed to bring it approximately into equilibrium. The examination consisted in centrifuging 10 c.c. of the mixture and determining the electrical conductivity at 0° C. For this purpose centrifuging is unnecessary, but the samples were in some cases used for hydrogen-ion and for phosphate determinations. In this way Atkins found that the conductivity of soil extracts varies according to the time of extraction. In more fertile soils the conductivity after 4 to 11 days is more than twice the value obtained after 3 or 4 hours extraction. The maximum value is reached quickly in infertile soils, which give an extract of very low conductivity. A high electrical conductivity may only show the presence of an excess of salts, but Atkins concluded that a rapid increase in conductivity may be considered as a useful indication of fertility.

The procedure adopted by Dr. Atkins has been modified by Dr. Sen and by the author. In the method adopted by the author [8] 10 grams of each soil sample are transferred to 250 c.c. Erlenmeyer flasks with waxed corks. To each flask are added 50 c.c. of conductivity water at 5 p.m., and the flasks are then shaken. After again shaking at 7 p.m. the soil extracts are allowed to stand till 9 a.m. next morning, when they are filtered into similar flasks, and the specific conductivities of the filtered extracts are determined at 0° C. The increase after 7 days was determined by

finding the specific conductivity of a 1 to 5 soil extract as described above, and then finding the specific conductivity after 7 days and 16 hours. For the latter determination there is required a duplicate soil extract, which should be kept at a constant temperature for 7 days.

Sen[5], working at the Agricultural Research Institute at Pusa, adopted the following procedure :—One part of soil was mixed with 5 parts by weight of conductivity water in a glass tube closed at one end. The open end was closed with a paraffined cork carrying a dip-electrode, which dipped into the soil extract. The apparatus was placed in a thermostat maintained at 30° C. and the conductivity of the soil extract was determined at intervals. The dip-electrode consists essentially of two platinum plates fused to the ends of two glass tubes, which are fixed at a definite distance apart. The platinum plates are protected by an outer glass tube, so that they can be immersed in the solution under examination, which is contained in a wide test tube : the dip-electrode and test tube together thus form a conductivity cell. A dip-electrode can be transferred from one soil extract to another after washing the platinum plates with conductivity water and drying them with filter paper. Since the quantity of water adhering to the plates is negligible, it is possible to determine in this way the conductivity of the same soil extract at intervals without affecting the soil to water ratio. The dip-electrode is therefore preferable to an ordinary conductivity cell for soil extracts.

Dr. Sen and the author [6], working together at Rothamsted Experimental Station, adopted the following method of measuring soil fertility :— 10 grams of air-dry soil were taken in an 8 in. Pyrex test tube, to which 50 c.c. of conductivity water were added. The tube was closed by means of a paraffined cork and the mixture was shaken for half a minute. It was then allowed to stand in a thermostat at 25° C., and after 24 hours the conductivity was determined with a dip-electrode. The latter was withdrawn and the tube containing the soil extract was left in the thermostat. On the fifth day the tube was shaken for half a minute, and on the eighth day the final conductivity was determined with the same dip-electrode. The difference between the final and the initial conductivity gives the 7 days increase.

Application to a Soil Problem.

Samples of soil were taken during September, October, November and December, 1924, from the cotton plots at Oyo and Ilugun on which Dr. Mason and the author [4] were then working. The plots at Oyo were between the 40th and 48th mile posts on the Oyo-Ogbomosho road, and the plots at Ilugun extended along the Ibadan-Abeokuta road for a distance of about 10 miles. In these two groups there is great variation of soil type within a comparatively limited area. The specific conductivities of the 1 to 5 soil extracts prepared from these soils were determined at 0° C. after standing 16 hours, and in most of these soils there was a slight decrease in conductivity between September and December. We found relations between the mean specific conductivity of the November and December samples and the number of open bolls per acre for American and native cotton, which could be expressed as follows :—If K = the mean specific conductivity of the November and December samples in millionths of a mho, and N = the number of open bolls per acre in thousands, then

$$N = 18.74\ K^{0.37}$$ for American cotton,

and $$N = 8.73\ K^{0.63}$$ for native cotton.

On these plots at Oyo and Ilugun there was no marked relation between the specific conductivities of the soil extracts and the yields of seed-cotton ; this perhaps is not surprising because the plots were widely separated and the damage caused by insect and fungous pests varied greatly on the different plots. But relations between yield and specific conductivity were found on the Botanist's cotton selection plot at Moor Plantation, the Headquarters of the Agricultural Department. This plot was under different strains of Ishan cotton. The rows were 6 feet apart, and it is probable that under these conditions the damage caused by insect and fungous pests would be nearly the same on all the rows. Soil samples were taken in January, 1926, from 11 rows under strain B and 11 rows under strain D. The soil on these rows was very variable ; the specific conductivities of the 1 to 5 soil extracts at 0° C. varied from 110 to 24 millionths of a mho. It was found that if W = the mean yield of lint per plant per row in grams, and K = the specific conductivity of the 1 to 5 soil extract at 0° C. after standing 16 hours, then

$$W = 11.65\ K^{0.91}$$ for strain B

and $$W = 7.84\ K^{0.86}$$ for strain D.

Other data have been presented by the author [8] showing that the specific conductivity of a 1 to 5 soil extract is an index of the fertility of the soil. In Nigeria the fertilities of soils can be compared in this way only when the soil samples are taken at the same time of the year, because the specific conductivities undergo seasonal changes, the values being highest in March (at the end of the dry season) and lowest in June and July (during the rainy season). In 1928 samples of soil were taken at frequent and regular intervals from three plots under maize at Moor Plantation, and the specific conductivities of the 1 to 5 soil extracts were determined. In the same soil samples nitric nitrogen and soluble calcium were also determined in parts per million. The maize was planted on 7th April and reaped on 9th August, and soil samples were taken from 2nd March until 24th August. This period includes the times when the specific conductivities reached their highest and lowest values. It was found [9] that changes in the specific conductivities were accompanied by corresponding changes in the nitric nitrogen and soluble calcium. The correlation coefficients between specific conductivities and nitric nitrogen

are 0.905, 0.916 and 0.918 for each of the three plots; and the correlation coefficients between specific conductivities and soluble calcium are 0.858, 0.790 and 0.772 for the same plots. It is probable that the fall in the specific conductivity in the rainy weather is due to leaching and removal of electrolytes by the growing crop. The correlations between specific conductivity, nitric nitrogen and soluble calcium show that the rise in specific conductivity during the dry season is due to biological activity in the soil. The same correlations also explain why the specific conductivity of a 1 to 5 soil extract is an index of the fertility of the soil.

The cotton plots at Ilugun, which have been mentioned above, were cleared from bush on native land in the middle of 1924. After one crop of cotton was grown for experimental purposes some of these plots were under native cultivation in 1926. In that year soil samples were taken from four of these plots by the author [8], who found a decrease in the specific conductivities of the 1 to 5 soil extracts, not only in the conductivity determined after 16 hours, but also in the increase after 7 days. The results, however, were not conclusive because the period during which the soil samples were taken was too short. The author, wishing to pursue the subject further, asked for permission to examine some of the soil samples which have been taken at intervals from the Rothamsted classical plots and are carefully preserved in bottles. He was fortunate in being able to do this work at Rothamsted in co-operation with Dr. Sen, who was then working on electrical conductivities of soil extracts prepared from soil samples from many of the plots at Rothamsted and Woburn. From Broadbalk, Plot 3, on which wheat has been grown continuously without any manure since 1843, there are 10 soil samples taken at intervals from 1846 to 1927; but from other plots fewer soil samples are available. Dr. Sen and the author [6] found that under continuous cropping the initial conductivity of an unmanured soil decreases to a minimum and then remains fairly constant. On the other hand, the 7 days increase decreases progressively, and is closely correlated with the yield.

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TEA.

Tea, in company with several products, has suffered during the past year from a severe depression. Increasing production resulted in the accumulation of such huge stocks that prices were depressed in some cases to below the cost of production. A special correspondent of *The Times Trade and Engineering Supplement* (24th May, 1930), states that the various producers' associations representing India, Ceylon, Jamaica and Sumatra, agreed to co-operate in an endeavour to restore stability to the market by means of a graded restriction scheme applicable to all tea producing countries. It is believed that this policy of "finer plucking" so frequently advocated, will not only alleviate the present lamentable state of the industry but will also result in the production of those better quality teas which the public appreciates. An important feature of the year was the abolition of the tea duty in the 1929 budget, and the disappearance of two-thirds of a penny in favour of Empire grown teas. The immediate result was a rise of about a penny per pound in the price of Java and Sumatra teas, and an increasing shipment of these growths to Great Britain. The immediate future is rather obscure. Large areas have been planted in recent years in both Southern India and Sumatra, and tremendous expansion is possible in the latter country, provided an adequate supply of labour can be obtained. Considerable development has also taken place in the infant Empire industries of Nyasaland and Kenya Colony. In Nyasaland, the area under tea has increased from 260 acres in 1904 to over 7,000, producing more than two million pounds of tea, in 1928. In Kenya, land under tea has increased to nearly 5,000 acres. Experiments have also been conducted in Malaya, where both soil and climate appear suitable for tea.

MONTSERRAT TOMATOES.

Mr. C. A. Gomez, Curator of the Experiment Station, reports that with a view to the development of an export trade in tomatoes, large nurseries were laid out and planted with tomato varieties in order to ascertain what varieties would suit local conditions of soil and climate, and at the same time prove a success on the Canadian market. Of the varieties grown "Bonny Best" and "Stone" appear best from an all-round point of view. Experiments with tomato shipments to Canada were also conducted. Tomatoes shipped in cold storage were a failure, while those shipped in cool chamber at 60° F., after being in a steamer eight days, reached Canada in perfect condition. This experiment is intended to form the nucleus of an export trade of tomatoes with Canada. Up to the present, 1,000 crates of tomatoes have been shipped by the recently organised Peasants' Bureau under the control of the Department of Agriculture and there is promise of greater development next season. — (*Bulletin of the Imperial Institute*, Vol. XXVII, No. 2.)

MYCOLOGICAL NOTES.

Cushion Canker of Cacao.

In a study on the course of infection in cushion canker of cacao (*Phytophthora faberi*) in the Gold Coast, some 200 lightly wounded pods were inoculated with the fungus. Half of these were dissected at intervals after inoculation and the remainder left for dissection in the coming season on the resumption of activity by the fungus.

It was found that invasion of the peduncle, as far as its insertion on the 'spur,' occurs at a very early stage. The fungus spreads both in the cortex and in the medullary rays of the dissected stele. The vascular segments of the xylem do not appear to be invaded, though they are deeply discoloured in the diseased areas. The check to the progress of the fungus through the cortex on its arrival at the spur may be due to the perennial nature of the latter. In the vascular strand the organism proceeds unchecked, still by way of the medullary rays. Later the cortex of the spur and cushion are usually attacked, the entire cortex of the cushion sometimes being involved. Occasionally infection spreads to the bark of the main axis, where an active canker is formed, but in practically all the cases examined, where only the spur and cushion were attacked, the cankered portions dried up about two months after inoculation and were cut off from the crest of the cushion tissues by a cork cambium. The dried masses of dead tissue were detached from the live bark, from which they eventually fell away. Ultimate recovery of the diseased bark is usual, though the attack extends over at least two seasons. During active infection a succession of cork meristems are formed, and these are the origin of the fine red lines constituting a visible network in the freshly cut diseased tissue. At the end of general invasion, normally covering only a few square inches of the bark, a cork cambium is formed which successfully isolates the diseased portion of the bark, causing it to become detached from the healthy tissues, and regeneration begins.

In the vascular strand the fungus progresses as far as the insertion of the trace on the main stele. Between the spur and the insertion of the trace the general discoloration of the strand thins out more or less into black lines, in longitudinal sections, or spots in transverse sections. The discoloration has been found to be due to the accumulation of gum and tannins in the large vessels and adjacent cells; it may be traced right down into the cambium of the trunk, to a distance of three or four inches below the cushion. No hyphae have yet been found beyond the insertion of the peduncular strand, so that further discoloration may possibly be attributed to a remote toxic effect. Cells on both sides of the cambium are involved, several layers on the phloem side being killed while only two or three on the xylem side are affected. Infection of the medullary rays may extend for a quarter of an inch just below the cushion, the diseased tissue being up to one inch in width.

Dissections of experimental material made three months after inoculation showed no further advance, the progress of infection apparently having been temporarily arrested by seasonal physiological changes in the host.

During the growth and maturation of the pod, the canker spreads rapidly into cushions from previous bark infections. After the destruction of the pod, however, the cushion and surrounding bark manifest a certain degree of resistance to attack. These facts would seem to indicate some modification in the physiology of the host tissue related to the nutritional conditions connected with the presence or absence of the growing fruit. Similar changes are probably responsible for the arrested activity of the fungus on its arrival at the cambium and for the renewal of growth in the bark at the beginning of the following season.

The presence of the fungus in the damaged cambial region below the cushion has not yet been demonstrated, but there is strong circumstantial evidence that it occurs in this part, the cells of which exhibit phenomena identical with those of the tissues containing hyphae, *i.e.*, tylose, gum, and tannin formation, increased deposit of calcium oxalate in the phloem and medullary ray cells, and discoloration.—(*The Review of Applied Mycology*, Vol. IX, Part 3.)

* * *

Fungi attacking *Diatraea saccharalis Fabricius* in Cuba, by H. K. Plank.

During investigations conducted in Cuba since 1925 into the sugar-cane moth stalkborer (*Diatraea saccharalis*) on the larvae of which *Cordyceps barberi* Giard was reported in 1915 near Havana, a conidial form attributed to this fungus was occasionally found in several different localities; other, previously unreported fungi found on this insect in Cuba (which are listed, together with the stage and months of attack) comprised *Aspergillus flavus*, *A. fumigatus*, *A. sydowi*, *A.* sp., a *Fusarium*, a *Penicillium*, and a fungus belonging to the *P. luteum* group. None of these organisms appeared to be of any practical importance in borer control.—(*Rev. of Applied Mycology*, Vol. IX, Part 5.)

* * *

Defective Cacao.

One of the most serious defects of fermented cacao beans exported from the Gold Coast is that caused by the presence of internal moulds belonging predominantly to nine species, viz., *Aspergillus glaucus* group (probably *A. chevalieri*), *A. fumigatus*, *A. tamarii*, *A. flavus*, *A. ochraceus*, *Penicillium* sp., *Mucor* sp. (cymose), *Absidia regneri*, and *Circinella spinosa*. Investigations have shown that this source of damage can be almost entirely avoided by thorough drying of the produce and keeping it from any contact with fresh or salt water, either of which favours the development of the moulds, practically every bean being contaminated with spores of one or more of these fungi before it leaves the producers' hands.—(*The Review of Applied Mycology*, Vol. IX, part 3.)

TROPICAL WORLD NOTES.

Sierra Leone.

According to Mr. Stockdale's report on his visit to West Africa, in the Colony itself poor crops are being raised on worn and washed out soils. The Protectorate is mainly gently undulating country which is being deforested and its soils reduced in fertility by "shifting cultivation." The rainfall throughout is heavy and soil losses are in consequence considerable. The chief crop is upland rice. This is sown in May after the bush is burned and the crop is harvested in November to December. A millet is sown at irregular intervals throughout these rice farms and this type, which appears to be peculiar to Sierra Leone, ripens about December. A few sticks of cassava are also interplanted in the rice and occasionally a few seeds of the native Quande cotton are sown. When these crops have been harvested, the land is allowed to revert to bush and this, after periods varying from four to eight years, is burned again for a similar cropping. There are numerous extensive areas where bush will not grow any longer and where its place has been taken by a number of grasses. In the depressions between the gentle undulating hills there are large extents of inland swamps, where rice cultivation has begun and where, in recent years, such cultivation has considerably increased. This swamp rice yields larger crops than the upland grown rice and is more generally appreciated for consumption. The rice, both in the swamps and on the hills, consists of a mixture of types and no attempts have been made to isolate the more suitable kinds, or to discourage mixture. Sierra Leone can be pictured as a country passing through those evolutionary phases which similar wet and undulating countries in the East must have gone through in the earlier stages of their history. Cultivation of rice is passing from hilly lands, after exhaustion, to the lower swampy areas. The latter cultivation is the more permanent and should be encouraged. The cultivators can be assisted greatly by lessons which can be translated from the East and it seems very desirable that matters concerned with drainage, terracing, cultivation, and regulation of water should be investigated in Sierra Leone. In the Scarcies area, Sierra Leone has an area of deltaic rice lands which are capable of producing a considerably greater output, and experience of the East would be of value there. It is to rice cultivation that early attention should be directed, for there is an increasing demand for rice in the West African markets, and this can be met from Sierra Leone until the possibilities of the Sokoto area in Nigeria are further explored and developed. The problem of the high lands in Sierra Leone is one of some difficulty. Attempts have been made to introduce exotics but without success. These crops have been introduced to the growers before their suitability has been thoroughly tested, and a reversal of such a policy is very necessary. So far, the Department of Agriculture has been able to establish the value of the first generation of selected oil palms grown from seed introduced from Nigeria and some trials with coffees have been promising. Sierra Leone has an indigenous highland coffee which is of good quality. Liberian coffee does well and the growth of Robusta types is promising. More has to be learned, however, in regard to the cultivation of the latter coffees in Sierra Leone, as such questions as shade requirements and the treatment of the soil have not yet been fully investigated. The agricultural problems in Sierra Leone are amongst some of the most difficult in West Africa and will require very careful study before material progress can be achieved. Agricultural exports consist almost entirely of palm kernels and piassava fibre and are not likely to expand to any great extent. There is a little land suitable for cacao and such land must be carefully selected if disappointment is to be avoided. The prospects before improved oil palms and coffee appear to be promising, but require further investigation. Coconut cultivation can be extended to a limited extent on some of the coastal areas, pepper may be suitable for some of the better valley lands, and an expansion of rice growing for export is possible. A greater amount of investigational work is, however, required, and reorganization in the work and disposal of agricultural officers is desirable.

* * *

British Guiana.

Statistics of the import and export trade of British Guiana published in *The Commercial Review* (Georgetown), reveal a further falling off in the trade of the Colony during last year. Exports amounted to $11,917,239, which is about 14 per cent. less than in 1928; and the total of listed imported commodities at $9,179,475, is some $1,164,500 less. Decreases have been general in both aspects of trade and in exports, sugar, rum, diamonds and molasses more than accounted for the deficiency, increases occurring in bauxite, timber and gold.

In spite of the reduced export—100,447 tons as against 114,687 tons in 1928—and unsatisfactory prices, sugar alone accounted for practically half of the export trade, with a percentage of 49.05. Shipments to the United Kingdom aggregated $1,619,965, or 27.1 per cent., while those to Canada amounted to $4,300,244, or 72.33 per cent. Exports of rum and molasses were both less than in either of the two preceding years, and rice showed a considerable decline at 14,091 tons, valued at $876,408, as compared with 1928. Coconut products as a whole increased in quantity but decreased in value, due to lower prices ruling for copra, and the export of timber was nearly three and a quarter times that of the 1928 quantity. Shipments of balata were less at 599,897 lb., and diamonds totalled 128,115 carats (rather more than half went to the United Kingdom), as against 132,966 carats, the value of last year's shipments being $2,277,567.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Absorption of Atmospheric Oxygen by Limed Cane Juice. J. A. Ambler.

Oxygen is absorbed by cold limed cane juices, with the formation of acidic products which cause a decrease in the alkalinity of the limed juices. The amount of oxygen absorbed is greater with high than with low percentages of lime. By plotting the volume of oxygen taken up against the duration of time, characteristic curves are obtained which show rapid absorption at first, followed by slower absorption. The rapid initial absorption is caused by a non-sugar which is removed by neutral lead acetate but not by lead nitrate. Solutions of invert sugar gives curves which indicate slow initial absorption, and which are of the same character as those of the lead acetate treated juice. The solution of a mixture of invert sugar with a small amount of tannic acid gives curves which have the same characteristics as those given by both the original juice and the juice after treatment with lead nitrate. The tannins and polyphenols of the juice are the chief absorbents of oxygen and the decrease of alkalinity in limed juices is due in part to the formation of acidic oxidation products of both the tannins and invert sugar.—(*Int. Sugar Jnl.*, Vol. XXXII, No. 378.)

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Harvesting Burned Cane.

Experiments on harvesting burned cane have obtained the unlooked for result that burning the cane before harvesting delayed any material deterioration in sucrose content and purity for about a week or nine days, whereas in the case of unburned cane the rate of deterioration was more or less uniform from the time of cutting. Further, cane left standing after burning showed no considerable deterioration after nine days and thereafter gave a gradual decrease in purity and sucrose content. These experiments have now been repeated, the same methods being used. The results confirm the previous conclusion that the burned cane deteriorates at a slower relative rate than the unburned, especially when the burned cane is left standing. This indicates that if cane is accidentally burned it will be better to leave it standing in the field until transport is available, as it will keep better than when cut.

Note:—It is considered by some that the better keeping quality of burned cane is probably due to the cane having been heated to 70° C. or more, thus killing the enzyme that transforms sucrose into invert sugar, and that cane which has not been heated to this temperature by burning probably will spoil faster than unburned cane.—(*Facts about Sugar*, Vol. XXV, No. 20.)

Continuous Filtration in France.

The sugar factory at Rue is working with an installation of the new Philippe filtering system, which comprises two distinct operations. The first operation is carried out in a tank having the external form of an ordinary Philippe filter, but which is considerably larger and in which the frames are replaced by perforated tubes covered by filter cloth. These tubes are grouped in elements or units of nine; the tank has 12 such elements and constitutes a thickener with a filtering surface of 32 square metres. Each element is connected to two pipes, one leading to a vacuum pump, the other supplying compressed air. The valves on these pipes are controlled by electromagnets which function alternately.

The tank being filled with first or second carbonation juice and the level of the juice being kept constant, the clear juice is drawn through the cloth surrounding the tubes, leaving behind the filter mud, which accumulates as a layer of gradually increasing thickness until the vacuum on the suction line becomes equal to 15 or 20 centimetres of mercury. The inlet for compressed air then automatically opens, the vacuum line closes, the deposit on the filtering tubes is dislodged and falls to the V-shaped bottom of the tank, where a screw conveyor renders the mixture of juice and mud homogenous and delivers it as a semi-liquid paste of 20 degrees to 24 degrees Baumé to a pump by which it is sent to the tank of a rotary filter. The drum of this filter is covered by a fine metallic cloth on which a layer of mud from seven to fifteen millimetres thick is deposited. The somewhat turbid juice from the rotary filter is returned to the thickener and the sweet water goes to the lime slacking tanks. The amount of wash water consumed depends partly on the nature of the muds. The second carbonation juice is filtered in a similar thickener but the muds, instead of being sent to a rotary filter, are returned to the thickener of the first carbonation juice.

In the first carbonation thickener the vacuum acts for six minutes and the compression three seconds; in the second carbonation thickener these periods are 12 minutes and three seconds. The capacity is variable, depending on the quality of the juice; two thickeners with 32 square metres filtering surface each suffice for a daily capacity of 750 tons of beets.—(*Facts about Sugar*, Vol. XXV, No. 16.)

WANTED TO PURCHASE.

Complete set of the *West Indian Bulletin*, formerly issued by the Imperial Department of Agriculture for the West Indies. Offers to *Bulletin*, C/o The Imperial College of Tropical Agriculture, 14, Trinity Square, London, E.C.3., England.

IRRIGATION IN THE ARGENTINE.

FIG. V.—*Irrigation of the Rio Negro Valley, F.C.S. Regulator of the General Roca Secondary Canal at Kilom 31 on the Main Canal.*

FIG. VI.—*Estacion Agronomica—New Extension. Showing the levelling apparatus and type of land to be dealt with.*

IRRIGATION IN THE ARGENTINE.

FIG. VII.—*Estacion Agronomica. Plot containing* 110,000 *vine grafts. Typical willow wind break in background.*

FIG. VIII.—*Estacion Agronomica. An Alfalfa Field with typical poplar and willow wind breaks.*

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Nitrogen Fixation by Bacteria.

That atmospheric nitrogen can be 'fixed' through the agency of leguminous plants and thereby made available as plant nutrient is common knowledge. The fixation process is known to occur in nodules which form on the host of the plants. It has been shown that these nodules contain bacteria (*Bacterium radicicola*) which are responsible for the fixation. These bacteria are present in most fertile soils and will enter the root hairs of any leguminous plants which may be introduced into the soil. The bacteria multiply in the new medium, nodules form, and nitrogen fixation commences. Although it is known that certain bacteria are capable of fixing nitrogen independently, it has been a matter of considerable investigation and debate as to whether *B. radicicola* are capable of fixing nitrogen independently of the leguminous host plant. The mass of evidence accumulated is conflicting. In a recent paper (M. P. Lohnis, *Soil Science*, p. 37, Vol. XXIX), the evidence is critically surveyed and it is shown that many conclusions are based on faulty experimenting. Further experiments conducted by the author herself, with careful elimination of the factors which induced errors in much of the previous work, show that it is most improbable that the *Bacterium radicicola* is capable of fixing atmospheric nitrogen in the absence of a leguminous plant. The conclusion is supported by other workers (Allison, *Jr. Agric. Res.*, p. 893, Vol. XXXIX; Hopkins, *Soil Science*, p. 433, Vol. XVIII).

* * *

The Addition of Bagasse to the Soil.

An investigation of the effect of sugar-cane bagasse on the general condition and the nitrate content of the soil is described by R. E. Kelsick in the Report of the Agricultural Department of St. Kitts-Nevis for 1928-29. Land was treated with bagasse at the rate of 15 tons per acre and a crop of sweet potatoes grown upon it. After cropping, analyses of the soils from treated and control plots showed a slight improvement in the physical condition of the former. The difference in the total nitrogen content of the two soils was hardly significant. The total organic matter was naturally greater in the treated plot. Humification of the bagasse had occurred to a slight degree but the humus of the untreated soil was much richer in nitrogen.

Experiments on the effect of the bagasse on the nitrate content of the soil were performed in pots. Pots containing similar soil were treated respectively with bagasse, ammonium sulphate, Humber fish manure, bagasse and ammonium sulphate, bagasse and Humber fish manure. Samples were taken periodically for 156 days. The nitrate content of the original soil measured in milligrams of nitrate nitrogen per 100 gms. of dry soil, was 2.2. At the end of the experiment this had increased in the control to 3.8. The nitrate content of the pots containing ammonium sulphate and fish manure only, increased to a maximum value of 5.9 and 8.0 after 49 and 77 days respectively. The soil in the pots containing any bagasse was depleted of all nitrate within seven days and showed no recovery at the end of 156 days.

These experiments confirm that great care must be exercised in the application of bagasse to the soil, or nitrogen starvation of the plants will result. It should only be applied after passing through a cattle pen or when the soil may remain fallow for at least seven months. Addition of nitrate with the bagasse would counteract the deleterious effects of the latter but the quantity required for so large a dressing would probably render the whole process uneconomic.

* * *

Recent Tobacco Soil Research.

It has long been known that the tobacco plant is a particularly useful indicator of nutrient deficiencies in soils. It responds markedly to fertilisers in pot experiments and, both in the greenhouse and in the field, deficiencies of potassium, magnesium, and calcium can be detected by their characteristic effects on the form of the leaves. The optimum reaction range is from pH 5.0 to 5.6, and the limits for successful commercial cultivation are pH 4.5 and 6.0; in neutral or slightly alkaline soils failure is generally associated with a root-rot. Tobacco is not successful when grown in rotation with other crops, and green manure crops before tobacco have very rarely improved the yields, and have frequently depressed both yield and quality. No adequate explanation has been found for this curious effect beyond the association of the failures with the occurrence of a brown root-rot, but the nature and origin of this disease are also not understood. The long discussion of the value or danger of using chlorides in tobacco fertilisers has led to the conclusion that, for bright flue-cured tobacco, about 20 lb. of chlorine per acre improves the yield and the texture of the leaves without adversely affecting the combustibility of the cured leaf. As the chloride addition is increased above this limit, the yield at first increases at the expense of burning quality until, with an excess, the growth is retarded and the leaves become thick and brittle. Potash fertilisers should supply the requisite amount of chloride with the bulk of the material as potassium sulphate or the mixed potassium magnesium sulphate. For dark sun-cured tobacco chloride should be omitted.—(*Annl. Rept. Prog. Appld. Chem.*, 1929, p. 555.)

REVIEWS.

The Cocoa and Chocolate Industry.

By A. W. Knapp. (*Sir Isaac Pitman and Sons*, pp. 188, illustrated. Price 7*s*. 6*d*.)

Originally published in 1923 as one of Pitman's Common Commodities and Industrial Series, this little book now appears in a second edition, as an independent and much more imposing production. Much of the matter has been re-written and brought up-to-date: while the author has added three chapters dealing with the composition and food value of cocoa, adulteration and definitions, and the storage of chocolate, all matters of considerable interest to the industry. The printing and illustrations are excellent, and the author has very fairly carried out his object of producing a book sufficiently free from technicalities to be appreciated by the layman but yet containing enough facts to make it useful as a miniature work of reference; within these limits the book may be thoroughly recommended.

R. C. W.

* * *

A Preliminary Study of Crop Yields and Rainfall in the Transvaal.

By D. G. Haylett, *Transvaal University College. Bulletin* No. 19.

This Bulletin describes a further instalment of work which is being done at the Transvaal University College, on the subject of the inter-relation between crop and rainfall. This subject is of particular importance in South Africa, and perhaps still more so in the Transvaal, and since Professor Plummer, the Professor of Geography, called attention a few years ago to its fundamental nature, it has been taken up assiduously by a team of University workers, including members of the Departments of Agronomy, Agricultural Chemistry, Engineering and Economics. Previous work dealt with the variability of the rainfall, and its general relation to the agriculture of the Transvaal: the present paper deals more particularly with the possibility of correlating the grain yield of the maize crop with the annual precipitation.

The work is described as preliminary, for it covers a period of only eight years, during which both rainfall and crop yields were most variable, but it indicates the methods adopted, and outlines further directions along which research will be effected. The author admits that the yield cannot be predicted with any degree of certainty from the rainfall figures alone, but he shows the possibility of determining the magnitude of the various inhibiting factors, such as losses due to run-off, or mal-distribution of rainfall. He is further able to show that in the Transvaal, the main critical period of this crop is the period of two weeks after flowering, *i.e.*, the date when 50 per cent. of the tassels are shedding pollen actively.

This is a very good illustration of team work, and we may confidently anticipate fruitful results. The data are reliable, the maize yields for instance are those from eighty plots, half of which are manured and half unmanured, scattered over the field experimental area of the Transvaal University College, and it would appear from the illustration, Plate I (Run-off Plots at the T.U.C. Experimental Farm), that full facilities are available for studying the problem in all its aspects.

An excellent bibliography is included.

R. C. W.

* * *

Farm Machinery and Equipment.

By H. P. Smith, M.S. *McGraw-Hill Publishing Co. Ltd.*, London. pp. 438. Price 16*s*. 3*d*.

During recent years improvements and alterations in the construction of farm implements, as well as the introduction of entirely new machines, have been so numerous that any publication dealing with the subject has rapidly fallen out of date. Reports of innovations appear from time to time in the agricultural and engineering press and descriptions can be found in makers' catalogues but there has been need of a comprehensive treatise which would provide information required by students as well as those engaged in the practice of agriculture. Smith's work removes this want—at any rate temporarily.

The author has intended the book primarily for the use of students and the first few chapters are accordingly devoted to an outline of elementary mechanics, a description of materials used, and a general discussion of the principles adopted in the manufacture of machinery.

Valuable suggestions are made in the chapter entitled "Selection of Farm Machinery." It is not usual to find the matter dealt with in a textbook such as this and just as it is ignored by the compilers of books so also does it frequently receive far too little attention from the buyers of implements. It is regretted, therefore, that the author, having introduced the subject, has not elaborated it still further.

In the old days a farmer who desired to purchase a new implement had no great amount of choice in the matter. A plough was a plough and one cultivator was much the same as another; in the case of barn machinery such as corn mills, there were probably not more than two or three on the market which were anything like the type required. To-day there are often dozens of implements to select from where formerly there were but few and each is designed to fulfil a particular purpose. Apart from cost, durability and other obvious considerations there is another which, although it should be the most obvious of all is too frequently overlooked, viz.: the question will the machine do the work which is required

of it and if so will the work be done efficiently and economically? Too often an implement is damned merely because it fails to accomplish a task to which its designers never intended it to be put and as a result it spends the rest of its life in the barn or more probably in the open yard. This is one instance, of the wrong type of implement having been purchased and there are many others.

Machinery for all purposes in both field and barn is dealt with in the succeeding chapters. The descriptions of the construction, function and means of adjustment of the various machines are concise and clear. Illustrations and diagrams, as excellent as they are numerous, have enabled the author to curtail the text to a minimum, an essential point when undertaking the description of as many implements as have been encountered here with so much success.

D. B.

ACKNOWLEDGMENT.

We have to acknowledge with thanks the following books which have been presented to the Library:—

The Principles of Tropical Agriculture. Tempany & Mann. *Incorporated Society of Planters*, Kuala Lumpur, F.M.S. Presented by the Authors.

Universitas Alexandrina Labacensis. Zgodovina Slovenske Univerze v Ljubljani do Leta 1929. Presented by Dr. M. Vidmar, Rektor.

BOOKS RECEIVED.

We have to acknowledge the receipt of the following books:—

The Measurement of Hydrogen Ion Concentration. Julius Grant. *Messrs. Longmans Green.* pp. 160. 9*s.*

The Cocoa and Chocolate Industry. A. W. Knapp. *Sir Isaac Pitman & Sons.* pp. 188. 7*s.* 6*d.*

Farm Machinery and Equipment. H. P. Smith. *McGraw-Hill Book Co.* pp. 448. 16*s.* 3*d.*

COLONIAL APPOINTMENTS.

The following appointments and transfer have been made recently by the Secretary of State for the Colonies:—

Mr. D. W. H. Baker, Superintendent, Agricultural Department, Nigeria.

Mr. W. J. Blackie, Government Chemist, Agricultural Department, Fiji.

Mr. M. H. Grieve, Assistant Agricultural Officer, Kenya Colony.

Mr. A. E. Haarer (District Agricultural Officer, Tanganyika Territory), Agricultural Lecturer, Tanganyika Territory.

COLLEGE NEWS.

Mr. A. K. Briant, lecturer in Mycology and Bacteriology, left for England on three months leave by the s.s. *Bayano* on 18th July.

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Mr. C. T. Watts, the College Engineer, accompanied by Mrs. Watts, left for New York on four months leave by the s.s. *Northern Prince* on 14th August.

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Amongst recent visitors to the College were Mr. L. S. Hohenkerk, the Acting Commissioner of Lands and Mines, British Guiana, and Captain H. O. Giffin of the R.M.S. *Lady Drake.*

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We extend our heartiest congratulations and best wishes to Mr. J. B. Hutchinson, the Assistant Geneticist at the Cotton Research Station, who was married on 9th July to Miss M. L. Johnson of Yorkshire. Mr. and Mrs. Hutchinson are expected to arrive in Trinidad on 20th September by the s.s. *Cavina.*

* * *

The College Staff and Students extend to Professor C. Y. Shephard their congratulations and good wishes on the event of his recent marriage to Miss Phyllis Pashley, which took place at Tacarigua Church, Trinidad, on 15th July. Professor and Mrs. Shephard sailed for Barbados on that day and returned to Trinidad on 7th August.

* * *

During his recent visit to Barbados, Professor Shephard investigated the possibilities of conducting an economic survey of the sugar industry of the island, and on Friday, 25th July, he addressed a meeting of the Agricultural Society on that subject. He also visited St. Vincent and discussed with the Administrator and Agricultural Superintendent the condition of the Agricultural Credit Societies. Through the courtesy of Mr. John de la Mothe he was enabled to inspect some cacao estates in Grenada.

* * *

A visit was paid to the Estate Farm, by the members of the Agricultural Society of Trinidad and Tobago, on the 2nd August, at the invitation of the Professor of Agriculture. The party, which numbered upwards of fifty, included several members of daughter societies, affiliated to the parent society, were taken round the fields to see the crops, their appreciation of which was increased by a brief typewritten guide with which they had all been supplied. After an interesting though rather warm morning, all the party collected for refreshments at the Junior Common Room, where Mr. A. B. Carr, M.B.E. expressed the thanks of the Society for the opportunity they had had in seeing something of what was being done here. It is to be hoped that this visit will become a regular affair.

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Prices on the Home Market have ranged as follows (*c.i.f.* per cwt.).—

	Foreign.		*Preferential.*	
	s.	*d.*	*s.*	*d.*
25th June	6	4½	10	3
2nd July	6	6	10	3
9th July	6	0	10	3
16th July	5	9¾	10	4½
23rd July	5	11¼	—	—
30th July	5	7½	—	—
6th August	5	9	10	3

Acute depression continues to prevail in the sugar market. Further record low prices have been established, and while there has been no addition to the factors responsible for the 'bearish' tendency, there has occurred nothing of a more reassuring nature. Although sugar can be produced nowhere at prevailing world market values there is no evidence of any intention on the part of the important producers to restrict production. On the contrary *Messrs. C. Czarnikow Ltd.*, in their Weekly Price Current of 17th July, report that Java, on account of favourable weather conditions, expects to equal last year's output; there is no reason to anticipate any reduction in the Cuban crop; all important European producers, with the exception of Poland, report increased sowings, while the United States Insular and Domestic production has received a stimulus recently in the shape of a higher protective Tariff. In the absence of any international agreement it appears inevitable that sugar will continue to be produced at below the cost of production.

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COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association:

	American Mid.	*Egyptian F. G. F. Sakel.*	*Sea Island.*		
			Good.	*Extra fine.*	*Prices paid this Week.*
27th June	7·74	12·55	24·50	38·00	8.50-25·00
4th July	7·63	12·25	24·50	38·00	27·00
11th July	7·73	12.45	24·50	38·00	11.00-28·00
18th July	7·68	12·40	24·50	38·00	25.50
6th August .... (local)	7·44	—	24·50	38·00	—

There is no improvement to be reported in general conditions. The acreage returned by the Bureau is 45,815,000, or 2.7 per cent. less than the planted acreage for the previous season, but as this had already been anticipated it had practically no market effect. Price fluctuations follow very closely cabled reports of weather conditions in the cotton belt.

* * *

COCOA.—Under the influence of continuous accumulation of July Exchange contracts and purchases of Sanchez in the open market by the leading member of the Accra Group prices were well maintained. Sales to manufacturers were rather unimportant. As regards price developments in the near future control of the market rests almost entirely with the Accra Group during the next three months. Provided its recent policy of accumulating nearby cocoa on a larger scale, while withholding sales of Accra is continued, the point must inevitably be reached when consuming demand has to cover autumn requirements.—(*By courtesy of The Cocoa Planters' Association of Trinidad.*)

* * *

COFFEE.—According to the *Times Trade and Engineering Supplement* of 26th July, imports for the six months totalled 659,000 cwt., compared with 526,000 last year, while stocks in bond at 429,000 cwt., show an increase of 112,000 cwt. On the whole a very fair trade appears to have passed. On 23rd July averages included Jamaicas, 190*s.*, Costa Rica Middling, 130*s.*, Kenya Good Middling 100*s.*, and Brazil Santos, 55*s.* 6*d.* per cwt.

* * *

TEA.—Latest weekly averages include Ceylon, 17.01*d.*, Indian 12.50*d.*, and Java 10.01*d.* (*Times Trade and Engineering Supplement*, 26th July). Sales this year have shown an increase but the average price at London tea sales this year, at 15.28*d.*, show an appreciable drop compared with 17.82*d.* for the corresponding period of last year.

* * *

RUBBER.—Quotations for Plantation Sheet have ranged as follows:—2nd July, 6 3/16*d.*, 9th July, 5 7/8*d.*, 16th July, 5 5/8*d.*, 23rd July, 5 7/16*d.*, 30th July, 5¼*d.*, 6th August, 5*d.* The market is still weaker and unsettled. A most disturbing feature is the fact that while production, particularly in Malaya, is expanding at rates far beyond all estimates, consumption has been falling off heavily. Some relief was anticipated from the announcement that "complete agreement" had been reached by the British-Dutch-Liaison Committee at their meeting in London on 26th June, *Messrs. Symington and Sinclair* reported that the Rubber Growers' Association was practically, but not entirely unanimously in favour of the recommendations, but that at the Dutch meeting there seemed to have been considerable dissent. The disappointing result of this meeting depressed prices still further.